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TOWARD AN AUSTRIAN THEORY OF ENVIRONMENTAL ECONOMICS

ROY CORDATO

Austrian economics lacks a formalized, self-conscious theory of environmental economics. But in fact all of the major elements of such a theory already exist and in that sense what is needed is to piece together the relevant aspects of Austrian economics in order to draw out and focus a theory that is already there.

The purpose of this paper is to do just that. In developing an Austrian theory of environmental economics, very little new theoretical ground will be plowed. But by bringing together Austrian concepts of costs and the praxeological foundations of economics we discover a unique perspective on pollution and the role of property rights in solving environmental problems. Furthermore by placing environmental problems within the context of personal and interpersonal plan formulation, we discover that they are not about the environment per se but about the resolution of human conflict.

WHY AN AUSTRIAN THEORY

Environmental economics is steeped in standard neoclassical theories of efficiency and Pigouvian welfare economics. These theories have been rejected by Austrian School economists as conceptually unsound and as yielding analysis that does not reflect the real world. This in turn has led to policy prescriptions that, while theoretically and formally elegant, are nonoperational.

In particular, environmental economics is an outgrowth of the theory of externalities and is primarily focused on maximizing the social value of resource usage. This is defined as that allocation of resources obtained in a perfectly competitive general equilibrium. Social inefficiency arises when the social costs associated with external effects, such as air or water pollution, are

ROY CORDATO is the vice president for research and resident scholar of the John Locke Foundation. The author would like to thank two anonymous referees for their helpful comments.

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not incorporated into the cost of producing the pollution generating product or its market price. From this perspective, the overall value of production can be increased to society by conforming the output of the pollution-generating product to the level that would be generated if the pollution costs were being reflected in its price. Under such a circumstance there would be an efficient reallocation of resources where less of the offending product and more of other goods and services would be produced. The value of the production gained will more than offset the value of production lost, increasing social welfare. When production and consumption are arranged such that all such pollution costs are accurately reflected in product prices, within the context of otherwise competitive markets, the market is said to be Pareto efficient, i.e., society, on net, cannot be made better off.

From this perspective, the process of production, exchange, and consumption in a strictly voluntary setting cannot be free of the kinds of inefficiencies generated by these negative externalities or "residuals" of the production and consumption process. Kneese, et al. (1973, p. 28) explains this inevitability as follows:

> If the capacity for the environment to assimilate residuals is scarce,[1] the decentralized voluntary exchange process cannot be free of uncompensated technological external diseconomies unless (1) all inputs are fully converted into outputs, with no unwanted material and energy residuals along the way, and all final outputs are utterly destroyed in the process of consumption, or (2) property rights are so arranged that all relevant environmental attributes are in private ownership and the rights are exchanged in competitive markets.[2] Neither of these conditions can be expected to hold in an actual economy.

The Austrian case against the standard Pigouvian approach has been argued (Cordato 1992a and 1995) and will not be recounted in any detail here. But in order to understand the genesis of the alternative, the core problems with the standard approach need to be made explicit. These problems can be summarized as follows:

1. Efficiency is a "praxeological," i.e., individual goal seeking problem, not a value maximization problem. From a policy perspective, then, social efficiency is assessed in terms of the extent to which legal institutions facilitate consistency between the ends that actors are pursuing and the means that they are choosing to accomplish those ends.

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[1]By this it is meant that the environment does not have the ability to naturally absorb environmental residuals in a way that is costless to society.

[2]This is the world of efficient outcomes as demonstrated by Coase (1960) where all relevant property rights are specified and, because markets are "competitive" transaction costs are zero and the inefficiencies associated with externality problems can be bargained away.

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2. Costs are subjective and therefore social costs and social value, as the terms are typically construed, do not exist as either measurable or even theoretical concepts. The standard approach is dependent upon being able to measure and therefore make objective these concepts. For example, the standard approach to environmental economics depends on being able to identify situations where the marginal private benefit of an activity exceeds the marginal social cost. This inherently involves making interpersonal utility comparisons and the summing of interpersonal evaluations across individuals. Neither of these can be held as methodologically valid.

3. Pareto optimality, i.e., the perfectly competitive general equilibrium, is irrelevant as a real world efficiency benchmark. This is largely because of the implications of 1 and 2. Because human action takes place through time, with knowledge and therefore supply and demand for inputs and outputs constantly changing, the particular Pareto optimum for any point in time is irrelevant. Strict adherence to subjective value and therefore subjective cost theory also leads to the rejection of Pareto optimality as a normative benchmark. Outside of a framework of unanimity it is impossible to talk about Pareto superior changes to a given state of the world without invoking interpersonal cost/benefit analysis.

While these arguments form the basis of a critical analysis of standard welfare and therefore environmental economics, they also allow us to bring to bear a uniquely Austrian perspective on both the positive and normative analysis of environmental problems. When viewed through the praxeological lenses of Austrian economics, with all that that implies, concepts such as pollution, environmental costs and degradation, and even the tragedy of the commons take on meanings that are quite different, and ultimately more rigorous, than definitions found in standard discussions.

The Praxeological Nature of Environmental Problems

Misidentifying Pollution as a Social Cost Problem

What constitutes an "environmental problem"? At first glance the answer might appear obvious. Issues like air and water pollution, animal extinction, or the over-use of resources, such as might be associated with the "tragedy of the commons," all come to mind. But of course this assumes a common framework of analysis that gives rise to certain definitions of these terms and explanations about why these phenomena are problematic. For example, consider a classic tragedy of the commons problem, commercial fishing in the ocean. The conclusion is that, absent the enforcement of legal constraints, any given species of fish will be "over-extracted" by fishermen who face every

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incentive to catch as many fish as possible now, before the next boat comes along. In other words, there is no incentive to conserve or restock or in any way nurture the given supply of fish. But on its face this discussion doesn't explain why this is a problem. Economists see the rate of fish extraction in the commons as an "environmental problem," rather than just one of an infinite number of extraction rates that are possible, because they have a "correct" rate in mind. From the perspective of standard environmental economics, this resource, the fish, is being over-utilized because the depletion rate is greater than would occur in a Pareto optimal world. The "tragedy of the commons," is a "tragedy" because fish are being extracted beyond the point where the marginal private benefit of the fish being caught are greater than the marginal social cost. It is therefore the starting point in terms of economic analysis that gives rise to the definition of not only a tragedy of the commons but all other environmental problems.

Very similar stories could be told with respect to issues of air and water pollution. Indeed, it is the underlying economic analysis that determines what is considered pollution in the first place. If a byproduct of production that is emitted into the air ends up giving rise to a divergence between marginal private benefit in the production of the associated product and marginal social costs, then the product output will be greater than its Pareto optimum level. That byproduct will then be defined as an air-pollutant. If, on the other hand, the byproduct does not have that result, for example water vapor, a byproduct of many production processes, then that byproduct is not considered to be a pollutant.

But as noted previously, this analysis does not give us a firm methodological foundation for identifying what is and isn't a pollutant. It rests on an approach to social costs that takes the analyst's eye off the ball: individual actors. The concept of social costs, as typically invoked, completely disembodies and impersonalizes costs. Social costs exist outside of and apart from individual choosers. As Richard Posner argues, "the question of whose cost is not a profitable one in economic analysis" (1973, p. 94). This view of costs becomes quite clear in applying concepts such as the Coase theorem or the Hicks-Kaldor compensation principle. With the former, the issue of who is imposing costs on whom is unimportant to the ultimate solution. As Posner notes, "the relevant question . . . is who could prevent the loss at lower cost, not whose cost the damage 'really' is" (p. 94). In the second, individual pollution cost bearers never need to be compensated for either past or ongoing harm so long as the output from the pollution generating production process conforms to a Pareto optimal solution. The relevant costs that must be overcome are not those that are being born by the victims but those that are being incurred by "society" because of the "misallocation" of resources generated by the externality. In both cases, what is important is whether or not the level of emissions and the joint output of all the affected production processes are "efficient." As we will see, in either case an "efficient" solution could be implemented without ever addressing the actual pollution problem as seen

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from an Austrian perspective.

The "social cost" approach to environmental economics has led to the "dehumanization" of issues related to the environment. Pollution or "tragedy of the commons" problems are not problems because of the damage that some people may or may not be inflicting on others, but because they create what amounts to disembodied harms. A problem occurs because some goods are "overproduced" while other goods are "underproduced." In its more extreme form this has led to a separation of the concepts of costs and harm from human beings completely, substituting notions such as "costs to the environment," and damage to the ecosystem. For example, Pearce and Turner in making a case for a tax on packaging claim that "environmental damage from packaging waste is not reflected in the prices of packaged products" and that "the size of the levy needs to be related directly to the environmental damage done by the production and consumption of the packaging, or to the costs of restoration to the environment" (Pearce and Turner 1992, p. 6). Nowhere in the article is there mention of actual people who are damaged. Costs are associated with "restoration to the environment" not compensating victims. Once the concept of costs is separated from individual human beings, i.e., from the act of choosing, it looses its footing and so does the economic analysis.

Pollution as Interpersonal Conflict

Economic analysis of the environment that starts from a praxeological perspective shifts the focus from maximizing the social value of output or equating price to marginal social cost, to efficient intra- and inter-personal plan formulation and execution, i.e., the internal consistency between the means that people use and the ends that they desire to achieve. Within this context, pollution problems that are indeed problems create an interpersonal conflict over the use of means and therefore obstruct efficient plan formulation and execution. Pollution is therefore not about harming the environment but about human conflict over the use of physical resources. Generally formulated, a pollution or environmental problem arises when individual or group A and individual or group B are simultaneously attempting or planning to use resource X for conflicting purposes. Unless emissions into the air, discharge into a river, or the extraction of fish from the ocean give rise to such a conflict then there is no economic, i.e., efficiency problem. Humans cannot harm the environment. Instead, they can change the environment in such a way that it harms others who might be planning to use it for conflicting purposes.

Most of the classic "textbook" environmental cases can be formulated in this context. Whether it's the problem of a factory discharging chemicals into a river and destroying the fishing downstream, or the odors from an animal farm fouling the air in nearby housing developments, or Coase's classic cases of straying cattle or railroads emitting sparks, they can all be seen as interpersonal conflicts. In each case people are simultaneously making conflicting plans with respect to the use of a physical resource, and it is this conflict that

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allows us to identify what is transpiring as an environmental problem. If there were no recreational users of the river or housing developments downwind from the pig farm there would be no pollution. Environmental problems are not really problems for or with the environment, but human problems of mutual plan formulation and the achievement of goals. From an Austrian perspective, Robinson Crusoe cannot be a polluter.

The Role of Property Rights

It is widely recognized, even within the most orthodox literature in environmental economics, that property rights have an important role to play in resolving environmental problems. Both more traditional Pigouvians, as exemplified by Kneese, et al. (quoted above) and their Coasean critics recognize to varying degrees that the origin and solution to environmental problems lie with the extent to which property rights are clearly defined. And, on this level, Austrians would agree.

But the praxeological approach described above gives rise to a different kind of property rights analysis and distinctly different conclusions concerning property rights based solutions to environmental problems. Whereas the standard approaches are focused on minimizing social costs or facilitating a Pareto optimum, the approach described here is focused on minimizing interpersonal conflict. For Austrians the role of property rights in abating such conflicts has its roots in Menger. In his *Principles of Economics*, Menger argued that all "economic goods" must come under the rule of private property in order to avoid conflicts of interest regarding their usage. He stated that

> when all members of society compete for a given quantity of goods that is insufficient . . . a practical solution to this conflict of interest is . . . only conceivable if the various portions of the whole amount at the disposal of society pass into the possession of some of the economizing individuals, and if these individuals are protected by society in their possession to the exclusion of all other individuals. (Menger 1981, p. 100)

In a later passage Menger seems to recognize problems that might be associated with air and water pollution or the tragedy of the commons where the resource in question is generally viewed as a noneconomic or free good. Menger, again referring the relationship between private property and human conflict states that

> It applies also to all non-economic goods with respect to which the boundary between requirements and available quantities is already so close . . . that any misuse or ignorance on the part of some members of the economy may easily become injurious to the others. . . . For these and similar reasons the phenomenon of property can also be observed in the case of goods that appear to us still, with respect to other aspects of life, as non-economic goods. (Menger 1981, p. 105)

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While under most circumstances and for most uses the ocean is essentially a noneconomic good, it may not be in terms of its use for harvesting certain kinds of fish. Or while the air may be considered a noneconomic good for many uses, it may not be if one of those uses is to emit odors from certain farming activities. As Menger argued, the only "practical solution" to conflicts that arise over the "economic" aspects of these otherwise "noneconomic" resources is private property.

For Austrians then, if the defining characteristic of pollution is that it is the consequence of a human conflict over the use of a resource, then it is logical that both the origin and the solution of the problem is to be found in a lack of clearly defined or enforced property rights. This property rights approach to negative externalities can be found in the work of most Austrians who have written on the subject. But what has gone unrecognized is that the writings of Mises, Rothbard, and others on this subject have been an application of insights found in Menger regarding the nature of and the solution to human conflict in a world of scarcity.

Resolving Conflict vs. Solving a Maximization Problem

The focus of the Austrian approach to environmental economics is conflict resolution. The purpose of focusing on issues related to property rights is to describe the source of the conflict and to identify possible ways of resolving it.

For both Coasean property rights analysts and more traditional Pigouvians, the goal is different. It is to achieve some form of "optimal" distribution of resources. Coase, in his analysis, seeks to maximize the total value of output, and alternative property rights arrangements are seen in this light. As he notes in his classic 1960 article, "one arrangement of rights may bring about a greater value of production than any other" (Coase 1960, p. 16). For Pigouvians the goal is to achieve a Pareto optimal distribution of resources by seeing to it that the generator of negative externalities considers all social costs in making production or consumption decisions. In both cases attention is diverted from those who are party to the conflict and toward finding a "value" maximizing allocation or resources. But from an Austrian perspective this is not a tenable goal as it necessarily involves interpersonal utility comparisons and unreasonable assumptions about human knowledge and the static nature of the world (Cordato 1995). This is why, as noted above, a solution to a particular problem may be "efficient" within Coasean and/or Pigouvian context but irrelevant from an Austrian perspective. For example, it is unlikely that a Pigouvian tax, even if it could be appropriately calculated, would do anything to solve the "Austrian" problem. If the tax is collected only to bring about the correct price/output combination and an "optimal level of pollution" (à la the Hicks-Kaldor compensation principle), leaving the initial conflict unresolved, there would be no reason to consider the solution to be efficient from an Austrian perspective. For similar reasons, the same would be true if a Coasean judge decided to allow a pig farmer to continue to emit odors

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into local housing developments because the homeowners are the "least cost avoider."

Property Rights and Public Policy

For Austrians then, public policy in the area of the environment must focus on resolving these conflicts over the use of resources that define pollution, not on obtaining an ultimately unobtainable "efficient" allocation of resources. The traditional Austrian approach to property rights analysis in this area can and should be seen in this light. Also, by viewing the works of Rothbard, Mises, Block and others from this perspective of conflict resolution one can obtain a better understanding of why Austrians have been so critical of Ronald Coase's approach to property rights analysis. While property rights are equally important for Coaseans and Austrians, their normative goals are significantly different.[3] For Coaseans the focus is on alternative rights arrangements and maximizing the value of output. For Austrians, whose goal is to resolve conflicts, the focus is on clarifying titles to property and rights enforcement.

If a pollution problem exists then its solution must be found in either a clearer definition of property rights to the relevant resources or in the stricter enforcement of rights that already exist. This has been the approach taken to environmental problems by nearly all Austrians who have addressed these kinds of issues (see Mises 1998; Rothbard 1982; Lewin 1982; Cordato 1997). This shifts the perspective on pollution from one of "market failure" where the free market is seen as failing to generate an efficient outcome, to legal failure where the market process is prevented from proceeding efficiently because the necessary institutional framework, clearly defined and enforced property rights, is not in place.

Two Approaches to Conflict Resolution: Polluter Pays and First Come First Served

A pollution problem then can take one of two forms, either titles to the relevant resources are clear but the rights to use that property by the title holders are not being enforced, or titles to a resource are not clear and two or more parties wish to use the resource for conflicting purposes. Obviously, each of these would require a different approach to solving the problem. But in each case the solution should focus on resolving the conflict and therefore allowing for the efficient formulation of plans by all parities involved.

[3]Austrian disputes with Coasean property rights analysis have been detailed in a number of articles and will not be recounted here. For only a sample of these articles see Block (1977); Cordato (1992b); Krecke (1996); North (2002).

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The polluter pays principle[4]

In environmental policy the polluter pays principle is an outgrowth of Pigouvian welfare economics. The optimal price-output combination will arise in a market when external pollution costs are reflected in the marginal cost of production, i.e., are internalized by the polluter. In other words, if the polluter is made to "pay" a dollar amount that is equivalent to the marginal social costs associated with the pollution that he is generating, "efficiency" will prevail. Generally speaking there are two approaches to applying the polluter pays principle. The most traditional and straightforward is the Pigouvian excise tax. In this case the polluter is forced to "pay" either through a tax that is equivalent to the "pollution costs" per unit of output or per unit of effluence. The second is through tradable emissions permits. In this case an "efficient" level of pollution is determined and permits to pollute which total to this efficient level are bought and sold in the marketplace. The polluter is forced to pay either explicitly by having to purchase permits in the market or implicitly by having to forgo selling the permits that he holds.

There are two fundamental problems with these approaches to "making the polluter pay." First is that both of these approaches are fundamentally forms of market socialism and suffer from all of the problems that Austrians have typically made against central planning (Cordato 1997). Most specifically, a central authority must know in advance what the efficient outcome is. In the case of the tax, a central authority must know in advance the exact amount of the externality costs being imposed by the polluter, and the correct price and output, not only for the good in question but, since efficiency only makes sense in a general equilibrium context, for all other affected goods and services. In the case of tradable permits, the knowledge requirements are essentially the same. This is because the central authority must first determine the "efficient" level of emissions for the particular pollutant, which also must be determined within the context of a general equilibrium solution.

A second problem is that the focus is on achieving the efficient price/output combination and not eliminating the conflict or the harm that is being generated. "Internalizing the cost" typically means seeing to it that the producer/polluter faces a marginal cost curve that would be the same as the curve that would be faced if he were bearing all the costs of production including the costs associated with the pollution. Whether or not the costs that third parties bear are eliminated or compensated for or the intrusion into their plan formulation process is ended is incidental and ultimately irrelevant. This is particularly obvious with respect to the tradable permits approach where an efficient level of pollution is chosen and potential polluters are issued permits to, in the aggregate, emit that level. From an Austrian

[4]For a more extensive discussion of the polluter pays principle within the wider context of contemporary environmental policy debates see Cordato (2001).

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perspective, after implementing such a policy you are still likely to be left with a pollution problem, all-be-it a possibly less severe one (see McGee and Block 1994).

In spite of these problems the polluter pays principle should not be jettisoned. When all property titles are clearly delineated, a reconstructed polluter pays principle that is rooted in the strict enforcement of property rights makes sense. A polluter is someone whose production byproducts are seeping onto the property of others and interfering with plans that they may have for the use of that property. By interfering with these plans the polluter is reducing the efficiency by which the victim of the pollution can pursue his or her goals. What is meant by "making the polluter pay" is that it is the polluter's responsibility, to the extent possible, to make the victims of the pollution whole (see O'Driscoll and Rizzo 1985, p. 142). There is a conflict over the use of a resource. The source of that conflict is the generation of a production byproduct that crosses from property that is owned and controlled by the generator of the byproduct to property that is owned and therefore should be controlled by a nonconsenting party. The responsibility for ending the conflict lies with the polluter who should be responsible for truly internalizing the costs of the conflict generating activity. In this case, internalizing the costs of the pollution does not simply mean facing a new supply curve that has shifted to the left by the right amount. For the polluter it instead means eliminating the costs of his polluting activities to those whose property usage is being curtailed. This might be done by eliminating the emissions, confining them to his own property, or by compensating the victims of the polluting activity by an amount that fully addresses the grievance.

First come first served

The second scenario under which a pollution problem can arise is when property titles and therefore property rights are unclear. A and B are attempting to use the same resource for conflicting purposes, with neither A nor B nor anyone else having clear rights to the use of the resource. A typical example might be where effluence is being discharged into a river that is being used for fishing or recreational purposes further downstream.

First of all, it should be made clear that in this type of case, the effluence is not really the problem. The problem that is generating the conflict is the lack of property rights definition. Typically, it is the scenario described by Menger where use of an otherwise noneconomic good becomes injurious to others and therefore, at least in that use, moves from noneconomic to economic. Unlike in the former case where the goal is to insure that "the polluter pays," in this case the goal is to determine who has the right to use the resource.

It should be noted that we cannot determine, as Coaseans might insist, that the rights go to the person whose use will maximize the overall value of production. There is no methodologically sound way of making such a determination. It also means that we cannot determine, without injecting a sense

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of personal aesthetics, that a more pristine resource, a portion of a river that is used for swimming or fishing, is preferable to a less pristine resource, the same area used as a waste receptacle. In other words, the responsibility for internalizing costs does not automatically go to the person generating the production byproduct.

In such a case, a solution might be to use the principle of first come first served (see Rothbard 1982). This has several virtues from the perspective of an efficient running market process. First it can reduce the possibility that a conflict will arise in the first place, or it might generate a negotiating process that could resolve potential problems before they arise. With the knowledge that a first user rule is likely to be upheld by the courts someone who desires to use a resource in a way that conflicts with a known first user will either decide not to go ahead with his plans or will go to the first user to negotiate a compromise. This also increases the level of certainty for the first user who can go ahead and implement his plans with reasonable expectations that his rights to use the relevant resource will be enforced in the face of others whose future plans might conflict. Such a rule would also increase the efficiency of the market process by reducing overall uncertainty in the plan formulation process by enhancing both the amount and quality of information that is captured in relative prices (see Cordato 1998).

Austrian Theories of Welfare Economics

Thus far we have avoided any detailed discussion of Austrian welfare economics. This is primarily because the theory that is outlined here does not hinge on acceptance of one or another of the more general standards for assessing social welfare found in the Austrian literature. In particular I refer to Rothbard's (1977) demonstrated preference standard of social utility; Kirzner's (1988) plan coordination standard; and Cordato's (1992a) knowledge based theory of catallactic efficiency. Instead it is derived from what all of these theories hold in common, namely Austrian economics' praxeological foundations. As such, this theory is consistent with all three of these approaches to social welfare.

The starting point for all Austrian welfare economics is the goal seeking individual and the ability of actors to formulate and execute plans within the context of their goals. Furthermore, in all three approaches, social welfare or efficiency problems arise because of interpersonal conflict. For Rothbard such conflicts arise because of interferences with the voluntary use of one's own property. This prevents a demonstration of true preferences, moving one to a lower level of utility than would otherwise be achieved. For Kirzner interpersonal conflict that cannot be resolved by entrepreneurship and the market process gives rise to a lack of plan coordination and therefore social inefficiency. And for Cordato, conflict, that similarly cannot be resolved by the market process, gives rise to catallactic inefficiency by preventing useful information from being captured by prices. A theory of environmental economics and

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pollution that evolves from problems associated with human conflict then would be a natural implication of each of these welfare standards.

In addition, these standards would argue that irresolvable inefficiencies, i.e., inefficiencies that cannot find a solution in the entrepreneurial workings of the market process, arise because of institutional defects associated with the lack of clearly defined or well enforced property rights. In a setting where rights are clearly defined and strictly enforced, plans may conflict but the resolution to that conflict is embedded in the exchange process. In other words, conflict may arise at the planning stages but is resolved before the actors proceed with implementation of those plans. For example, persons A and B may have conflicting plans with respect to resource X, but if ownership to X is clearly defined as being in the hands of A, B, or a third party C, then there will not be a conflict over the actual use of X. It will be understood by A or B that before proceeding with their plan they must gain rights to X. For Kirzner especially, the entrepreneur plays a key role in resolving this potential conflict by bringing together those who may have plans with respect to the use of certain resources and the resource owners.

In the absence of clearly defined and strictly enforced property rights this process breaks down and the conflict becomes irresolvable through the market process. Under all three Austrian approaches to welfare economics, therefore, the solution to pollution problems, defined as a conflict over the use of resources, is to be found in either clearly defining or more diligently enforcing property rights. Not surprisingly this is the approach that has been taken by nearly all Austrian economists who have looked at the issue dating back to Menger.

Conclusion

The purpose and one hopes the contribution of this paper, has been to reconstitute both positive and normative environmental economics "from the ground up" using the praxeological method of Austrian economics. As noted at the outset, this exercise is more about pulling together building blocks that are scattered throughout the Austrian literature than fashioning a completely new set of building materials. In pursing this goal we have integrated the Austrian focus on the actor's means-ends framework, including its emphasis on the subjective nature of value and therefore costs, with the definition of what constitutes an environmental problem. By defining such problems in these terms, both the nature of pollution and the definition of a polluter take on new meaning. Environmental problems are brought to light as striking at the heart of the efficiency problem as typically seen by Austrians, that is, they generate human conflict and disrupt inter- and intra-personal plan formulation and execution. This is in contrast to either Pigouvian or Coasean environmental economics, which defines pollution problems primarily in terms of resource allocation.

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It is also demonstrated that the property rights approach to policy analysis taken by Mises and Rothbard is not only conceptually different from the approach taken by Coase, but is a natural outgrowth of, and directly follows from its praxeological roots. The role of property rights in environmental economic analysis is integrated into the Mengerian role of property rights more generally. For Menger, the social purpose of private property is to resolve interpersonal conflicts and allow for the peaceful pursuit and fulfillment of plans. In pursuing this analysis modern Austrian discussions of environmental issues are seen as part of an historical continuum, starting with Menger.

The confusion that currently surrounds the formulation of environmental policy is an outgrowth of a theory of environmental economics that is fundamentally flawed. The standard approach is rooted in indefinable concepts of social cost and general equilibrium and implies policies that cannot be implemented in the real world. In light of this most economists have accepted the idea that their role is to devise efficient methods for achieving politically determined pollution or emissions targets. As noted by Lloyd Orr,

> economists have moved to the position of advocating effluent charges as a means of meeting politically determined environmental standards at minimum cost. The proposed solution establishes . . . the charge structure required to meet the predetermined standards. (Orr 1981, p. 57)

Politicians determine what is and isn't pollution and what the appropriate emissions targets are. The economist steps in to advise policy makers about how to develop an excise tax or a tradable emissions scheme that utilizes the "efficiency" of market incentives to achieve the politically determined result (see Cordato 1997).

Austrians can offer an alternative approach that does not depend on having to define or measure what is conceptually indefinable or unmeasurable. This is not to suggest that the clear definition of property rights is an easily achievable goal in all situations. It is not. But, while the Austrian approach to solving pollution problems may face implementation problems at the margin, i.e., with certain "tough cases," defining and enforcing property rights already stands as the fundamental way in which interpersonal conflicts of all kinds are avoided or dealt with. This approach is clearly operational as it has been in operation, to one extent or another, throughout human history. The challenge for Austrians is to explain how we apply the theory in certain tough cases, not to explain, in reality, how it can be applied at all.

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CAPITAL, MONETARY CALCULATION, AND THE TRADE CYCLE: THE IMPORTANCE OF SOUND MONEY

JOHN P. COCHRAN

As pointed out by Professor Kirzner (2001, pp. 137 and 140), Mises did not start out with the intent to develop a theory of the trade cycle. The trade cycle argument first appeared in the last few pages of the *Theory of Money and Credit* (1912). This early development of Austrian business cycle theory was a direct manifestation of Mises's rejection of the concept of neutral money and "emerged as an almost incidental by-product of his exploration of the theory of banking" (Kirzner 2001, p. 140). This development was an incomplete sketch of the theory, particularly for those not well versed in the capital theoretical foundations of the argument. In fact, Hayek's first exposition of his version of the theory appears in a long footnote in his 1925 paper "Monetary Policy in the United States after the Recovery From the Crisis of 1920." The note was added following a suggestion from Gottfried Haberler. Hayek (1999, pp. 105-06 n.) explained that since "no sufficient exposition of the theory I had used was to be found in Mises's published works and if I was to expect to be understood, I must give a fuller account of the theory underlying my reports of the events described."

The Austrian theory of the business or trade cycle is an intricate blend of monetary theory and capital theory. Mises's (and Hayek's) monetary and capital theories differ in both significant and subtle ways from the neoclassical approach. Economists working in the Misesean tradition are still plagued by problems of communication with non-Austrian economists. While the terminology used is similar in both theories, the definition of key terms, the understanding of the nature of the economic problem, and the role of prices, especially prices for the means of production, differ considerably.

JOHN P. COCHRAN is interim dean, school of business, Metropolitan State College of Denver. This article is a revision of the Mises memorial lecture that was given at the 2003 Austrian Scholar's Conference.

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Hayek did much of the work developing the "real aspects" of the business cycle theory, but, as has been pointed out by others, Hayek had one foot in the Austrian camp and the other foot in the Walrasian general equilibrium camp.[1] For this reason, Hayek can be an important bridge between mainstream and Austrian economics. Hayek can be read (or perhaps more easily read—reading Hayek is never easy) by a neoclassically trained economist with limited background in Austrian economics. In many cases his insights can be assimilated and at least partially incorporated into neoclassical analysis.

Many of the subtleties within Austrian business cycle theory and calculation arguments depend on Austrian capital theory and the Austrian understanding of the role of time in the economic process. Those relying on Hayek often interpret Hayekian arguments in terms of neoclassical capital theory and can be misled, as was Kaldor, to believe that Austrian business cycle theory

> was by no means so intellectually satisfying as it appeared at first. There were admitted gaps here and there in the first published account which was intended as merely rudimentary, and which when one attempted to fill these gaps they became larger instead of smaller, and new unsuspected gaps appeared. (Kaldor 1980, p. 148)

While there is much that is useful in Hayek's numerous attempts to answer his critics, one must go back to his mentor Mises and to what Lewin (1999, pp. 115-33) calls modern Mengerian capital theory to build a more complete and convincing response to Kaldor and similar critics. The response depends on the development of a theory of the market process of a monetary economy. As Lewin explains, while neoclassical and Ricardian capital theorists interpret Böhm-Bawerk within an equilibrium framework and focus on his empirical insights regarding the greater productivity of capital-using processes,

> modern Austrian (market process) theorists, following Mises, Hayek, Lachmann, Kirzner, and Rothbard (and also Frank Fetter) focus on some of Böhm-Bawerk's less formal pronouncements and draw some crucial insights from them. In particular these involve the role of time and the nature of profit and interest. (Lewin 1999, p. 71)

This market process theory leads to an understanding that monetary calculation and capital provide the only basis for rational economic planning. Rational economic planning is the foundation for the development and continuation of civilization based on social cooperation and the division of labor.

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[1]See Cochran and Glahe (1999, p. 88 n) and Salerno (1999, pp. 45-46). See Salerno (1993) for Weiser's influence on Hayek. Caldwell (2004, p. 143) argues "that Weiser was not a proponent of general equilibrium theory and could not, therefore, have influenced Hayek" in this way. The author follows Salerno here.

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Cycle Theory and the Development of the Monetary Calculation Argument

Peter Boettke has argued,

> The centrality of monetary calculation to Mises and Hayek is the unique contribution of the Austrian school of economics. Combined with the additional Austrian assumptions and theoretical propositions–irreversibility of time, uncertainty, time structure of production, heterogeneity and multiple specificity of capital goods, non-neutrality of money, and so on–monetary calculation emerges as not just an aspect of the market process, but the crucial element which allows for the social cooperation under the division of labor. (Boettke 2001, p. 44)

The arguments concerning the importance of monetary calculation for rational economic planning came to the forefront during the socialist calculation debate. The rational economic calculation argument was a development of Mises's earlier work in monetary theory and its extension to the trade cycle. For Mises and Hayek, the trade cycle theory was an attempt to integrate an understanding of a complex capital structure into a monetary exchange economy (Boettke 2001, p. 34). Austrian business cycle theory is based on intertemporal misallocation of resources. The real intertemporal pricing problem is the relationship between the prices of inputs applied at an earlier date to the prices of outputs available at a later date–the natural rate of interest in an Austrian model–and the market rate of interest in the loan market as influenced by credit creation. Kirzner highlights this point as a key element in Mises's theory. Mises

> relies on the reader's understanding the Böhm-Bawerkian insight that the money rate of interest simply corresponds, in a smoothly running economy at a given level of production, to the excess value of consumer goods at a given date, over the value–the spot prices–of the inputs invested at an earlier date in their production. (Kirzner 2001, p. 141)

It is in the development of the trade cycle theory that Mises, and later, Hayek recognize that rational economic planning involves not only monetary calculation–"in the absence of money, there are no economic quantities and no economic calculation" (Salerno 2002, p. 2)–but more importantly the appraisal of the value of resources available in earlier periods relative to the expected prices of the relevant output available at later dates. This is the entrepreneurial function and it cannot be duplicated in the absence of a market process where prices reflect the preferences and judgments of valuing, acting individuals. As pointed out by Salerno (1993, p. 123), "The real market process is driven by an identifiable, though ever changing, class of individuals whose productive activities are guided by monetary calculation based upon perpetual forecasting of an uncertain and changing future."

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The market environment necessary to allow this entrepreneurial planning process to function most efficiently is the connection between the monetary, capital, and interest rate theory that is the foundation of the Austrian business cycle theory and the development and refinement of the arguments advanced by Mises and Hayek in the socialist calculation debate. The key elements in this enabling environment are private ownership of the means of production, monetary calculation, capital, and sound money.

Monetary Calculation, Capital, and Sound Money

Recognizing the role and importance of monetary calculation requires a proper understanding of the economic problem, which is "to employ the available means in such a way that no want more urgently felt should remain unsatisfied because the means suitable for its attainment were employed—wasted—for the attainment of a want less urgently felt" (Mises 1998, p. 208). The very nature of this economic problem is misstated in standard textbook presentations. The problem is not the allocation of *known* scarce resources to satisfy *known* wants of *known* consumers based on a *known* lowest cost method of production for each *known* good and/or service. These "*knowns*" are not given, but are the elements that must and can only be discovered through a market process.

The task taken on by the entrepreneur is to make profits (and avoid losses) by attempting to meet the anticipated future wants of consumers in the most efficient way possible. This task is by its very nature speculative. But once one recognizes "the facts that life is not rigid, that all things are perpetually fluctuating, and that men have no certain knowledge of the future," then it becomes clear that "calculation is as efficient as it can be. No reform could add to its efficiency." The entrepreneur makes use of the mental tool of economic calculation to "adjust his actions as well as possible to his present opinion concerning want-satisfaction in the future. For this purpose acting man needs a method of computation, and computation requires a common denominator to which all items entered are to be referable. The common denominator of economic calculation is money" (all quotes from Mises 1998, p. 215).

Mises (1998, pp. 230-01) summarizes monetary calculation as a "method of thinking" that: (a) is the "guiding star of action under the social system of division of labor" where the entrepreneur "calculates to distinguish remunerative lines of production from the unprofitable," (b) is "commercial precalculation of expected costs and expected proceeds" and the *ex post* evaluation of past action as reflected in accounting profits and losses, (c) can operate only in an institutional setting "with the division of labor and private ownership of the means of production in which goods and services of all orders are bought and sold against a generally used medium of exchange, i.e., money," and (d) "reaches its full perfection in capital accounting."

The concept of capital is not a category of all acting, but only a category of acting in a market economy. Capital is an essential element in entrepreneurial

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planning. It is an estimate of the market value at a definite date of a particular business plan. As such, it "cannot be separated from the context of monetary calculation" (Mises 1998, p. 262). A given business or entrepreneurial plan implies a time structure of production for the individual enterprise–a pattern of inputs (capital goods, labor, and natural resources or land) applied at earlier dates followed by a pattern of outputs sold at later dates. Groupings of entrepreneurial plans imply a time structure of production for the economy as a whole made up of interconnected/complementary plans and competitive plans. Monetary calculation (forward looking capital valuation) and the continuous feedback from profits and losses prod entrepreneurs to continuously adjust plans toward the provision of goods and services most valued by consumers–toward solving the basic economic problem. Without market (money) prices, and especially market prices for the means of production, there can be no monetary calculation. Without private ownership of the means of production, there can be no markets for resources, no money prices for resources, and thus no monetary calculation and no capital. Without capital the economic problem is neither calculable nor solvable.

The fall of the former socialist countries has alerted most economists to the importance of markets and private property for long-term economic prosperity. There is, however, an additional important element that is critical if monetary calculation is to operate in a way most consistent with consumer sovereignty. That element is sound money. As expressed by Salerno,

> while there is now a basic recognition by economists that rational allocation of resources necessitates institutional reforms that return resources to private hands and restore genuine markets for productive inputs, there is no such comprehension of the importance of sound money to the processes of economic calculation. (2002, p. 1)

What is sound money? According to Salerno (2002, p. 4), "Sound money, then is simply one which does not lead to systematic falsification of or nullification of economic calculation." Economic calculation requires money prices, but for calculation to most adequately achieve the goal of solving the economic problem the money prices used for calculation must reflect the valuations of producers/consumers that are based on their individually unique preferences, knowledge, and resources. With sound money, money prices reflect valuation and action.

The following types of changes in the purchasing power of money are consistent with sound money: fluctuations in the purchasing power of money caused from the money side that reflect individual preferences regarding the holding of cash balances, valuations that induce individuals to engage in the discovery of and production of the market chosen money commodity, and changes in the purchasing power of money from the goods side. Such changes are part and parcel of the continuing market adjustments to an uncertain future.

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For any given market, prices fail to reflect individual valuations whenever there is a government intervention in the market. Entrepreneurs can still make plans based on controlled prices and, given the imposed constraints on behavior, such plans may be profitable and thus appear temporarily successful. But such plans are not consistent with the above goal of solving the economic problem. While not systematic (yet), economic calculation has been falsified. Extension of the price controls to most or all markets, as in the post "war communism" socialist economies, leads to explicit "systematic falsification" and/or nullification of economic calculation.[2] This is the type of calculation problem that eventually led to the decline and fall of the former Soviet bloc economies.

Sound money then is a money whose purchasing power and quantity are determined by consumers'/producers' valuations as determined by preferences, knowledge, and resources–that is, a market-determined commodity money absent government intervention. As expressed by Mises (1998, p. 225),

> Economic calculation does not require monetary stability in the sense in which this term is used by champions of the stabilization movement. The fact that rigidity in the monetary unit's purchasing power is unthinkable and unrealizable does not impair the methods of economic calculation. What economic calculation requires is a monetary system whose functioning is not sabotaged by government interference. The endeavors to expand the quantity of money in circulation either in order to increase the government's capacity to spend or in order to bring about a temporary lowering of the rate of interest disintegrate all currency matters and derange economic calculation.

Because money has no market of its own, money interventions permeate all markets. Monetary interventions and universal price controls create falsification problems that are immediately systematic, but the effects of monetary interventions are much more subtle.

Austrian economists are united on the goals of sound money–avoiding "calculational chaos"[3] and providing an "instrument for the protection of civil liberties against despotic inroads on the part of governments" (Mises 1971, p. 414). There is also general agreement that a return to sound money "involves abolishing central banking and paper fiat money and restoring a commodity money chosen by and totally subject to the market" (Salerno 2002, p. 4). There is, however, controversy over the means. Does sound money require 100 percent reserve banking or does it allow banking freedom?[4] Does one follow Mises:

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[2]See Boettke (2001, chaps. 6 and 7) and Osterfeld (1992, pp. 6-9).

[3]See Salerno (2002, p. 1) and Rothbard (1970, pp. 825-26).

[4]I deliberately use banking freedom here rather than the more familiar free banking to differentiate those who see banking freedom as consistent with sound money from those who advocate free banking as a means to offset the influence of changes in the demand for

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> Free banking is the only method for the prevention of the dangers inherent in credit expansion. It would, it is true, not hinder a slow credit expansion, kept within very narrow limits, on the part of cautious banks which provide the public with all the information required about their financial status. But under free banking it would have been impossible for credit expansion with all its inevitable consequences to have developed into a regular–one is tempted to say normal–feature of the economic system. Only free banking would have rendered the market economy secure against crises and depression. [And] [t]here is no reason whatever to abandon the principle of free enterprise in the field of banking. (Mises 1998, p. 440)

Or does one follow Salerno (2002), Herbener (2002), and Reisman (2000), who argue for 100 percent reserves on the basis of reform proposals made by Mises (1971, pp. 448-57, and 1978, pp. 17-21 and 44-47.)[5] In these proposals, Mises argued for 100 percent backing of any newly issued notes or checkable deposits. For reform of a monetary system on the verge of collapse or as a proposal for how we move from our current system toward a sound money system, such a step may be essential. After reform though, it is also essential that "the question of banking freedom must then be discussed again and again, on basic principles" (Mises 1978, p. 45).

Conclusions

Government control/intervention into the money system creates distortions in the money pricing system. These interventions lead to money prices that are not based on individual valuations and knowledge. Calculation errors will be in excess of entrepreneurial errors that are normal when planning for future provision of consumers' wants in the face of unavoidable uncertainty. Planning to meet consumers' most urgent demands is hindered, and in the case of a crack-up boom where no substitute money is readily available, so shortened in time horizon as to be effectively eliminated.

The arguments supporting a sound money policy were originally extensions of the Austrian business cycle theory. Credit creation systematically undermines capital-based entrepreneurial plans by increasing the difficulty

money on monetary equilibrium and the purchasing power of money. Banking freedom implies banks operate in an environment where the banks are subject to the general rules of commercial and civil law and are not the recipients of special privileges and protections granted by the state. As expressed by Mises (1998 440), "What is needed to prevent any further credit expansion is to place the banking business under the general rules of commercial and civil laws compelling every individual and firm to fulfill all obligations in full compliance with the terms of the contract." I owe this insight, the distinction of the agreement on ends and not means, and the inclusion of this discussion in the paper to some very helpful comments and suggestions made by Larry Sechrest.

[5]See Ebeling (2002) for other similar proposals by Mises.

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associated "with the relationships between resources at one point of time and outputs of subsequent points of time" (Kirzner 1996, p. 43). The crisis or bust following a boom is just a calculation meltdown cut short. The intervention is stopped or slowed and the falsified calculations are revealed. The corrective action of profit/loss feedback begins again to assert itself. Economic activity "recovers," as the market again begins a process to align business plans with consumers'/producers' valuations and available resources. If the intervention is not slowed or stopped, the inflation continues until a crack-up boom sets in with the associated complete calculation breakdown.

Sound money provides a financial environment where economic crisis associated with misdirections of resources and malinvestments can be avoided and where monetary calculation can be as efficient as possible. Economists who accept the Austrian argument on the impossibility of rational economic calculation in a socialist economy and recognize the calculation problems inherent in highly interventionist economies, but reject Austrian business cycle theory, should re-examine their position. The key elements for understanding the market process based on entrepreneurial planning, monetary calculation, and capital are the key elements underlying both the calculation argument and Austrian business cycle theory. Without sound money, calculation is less efficient and the economy will be prone to business cycles. With sound money, no boom-bust cycle will emerge and monetary calculation and planning will be as efficient as possible in an uncertain world.

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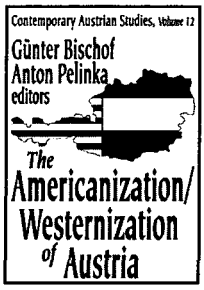

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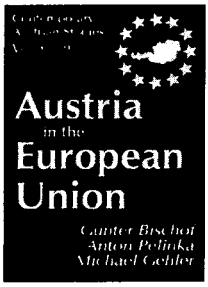

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THE HAYEK AND MISES CONTROVERSY: BRIDGING DIFFERENCES

ODD J. STALEBRINK

Almost a decade ago Joseph Salerno, Murray Rothbard, and Jeffery Herberner (hereafter referred to as SRH) published a set of articles in *Review of Austrian Economics* aimed at drawing a distinction between Ludwig von Mises's and Friedrich Hayek's respective explanations of the problem of socialism. In brief, they argued that Mises's calculation argument had sufficiently diagnosed the problem of socialism, prior to Hayek's entrance into the debate. They also argued that Hayek's analysis of the problem did not necessarily constitute an obstacle for the workings of the socialist state.

The arguments laid out by SRH for arriving at their distinction generated a series of immediate writings that added a significant amount of confusion to the subject matter. A first phase of writings emerged in the early 1990s and ended in 1997 (Rothbard 1991; Yeager 1994, 1996, 1997; Salerno 1994, 1996; Kirzner 1996; Hoppe 1996; Herbener 1991, 1996). These writings brought very limited progress toward resolving the differences that gave rise to the controversy. In essence, the discussions never reached further than to a mere discussion over what SRH had really meant. This is exemplified by Leland Yeager's question to SRH, which addresses their proposed distinction, as part of the final article published in the first phase of writings. Yeager asks whether or not SRH's arguments for a distinction had been an attempt to treat Hayek's and Mises's respective arguments as mutually exclusive. He did so, by challenging Salerno to conceive a situation in which Hayek's explanation "was not intimately bound up with the problem that Mises had diagnosed" (Yeager

ODD J. STALEBRINK is assistant professor of Public Administrtaion at West Virginia University. The author would like to acknowledge the support of the School of Public Policy at George Mason University for the research reported in this paper. Valuable suggestions for improving the paper were provided from the late Don Lavoie at the School of Public Policy, George Mason University, as well as from two anonymous referees. Any remaining errors are the sole responsibility of the author.

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1997). More recently, a second wave of articles addressing the subject matter has emerged, addressing the same issues that were raised in the original debate, albeit at a more detailed level (Salerno 1999, 2002; Caldwell 2002). Similar to the controversy of the 1990's, the debate continues to draw a wedge between Hayek and Mises, rather than searching for common ground.

The attempt here is to reduce the confusion that the controversy has generated and continues to generate, by providing an explanation of how SRH came to interpret Hayek and Mises as distinct rather than complementary thinkers regarding socialism. Specifically, it is illustrated that it was their view of Hayek as a near-equilibrium-theorist or "proximal" equilibrium-theorist that allowed SRH to draw a distinction. This means that Hayek conceives the economy as operating sufficiently close to a final or a static state of equilibrium, where present (i.e., immediately past) prices contain all the information necessary to guide producers in making optimal resource allocation decisions. This view provides for a future that is not very unlike the present, and where rational resource allocation does not emphasize the indispensability of a dynamic entrepreneurial appraisement process, which operates under uncertainty and involves forecasting future market data and appraising future output prices on the basis of qualitative and fallible forecasts. Hence, SRH's interpretation of Hayek is in sharp contrast with Mises's view of the problem of socialism. It is also illustrated in the paper that while there is strong textual evidence to support the SRH interpretation Hayek's view of the market, it deemphasizes Hayek's later wrtitings on the broader issues of social order and progress, which emphasizes "discovery" and "learning."

Addressing the confusion that has arisen from the controversy is important for two reasons. First, it is important for Austrian economists themselves. The main contribution of the controversy, thus far, has been to further existing differences between Austrians. This is troublesome, during an era when several Austrian economists are highlighting the importance of seeking common ground in Austrian economics. Kirzner, for example, urged the following in 1996:

> if we wish to preserve and build upon the Misesian legacy, we must not generate confusion (both among Austrians and their opponents) by exaggerating perceived differences between Mises and Hayek, to the point where the centrally shared insights of both are dangerously obscured. (Kirzner 1996, p. 154)

Addressing the confusion is also important because it directly challenges the view held by a significant number of Austrian economists (in particular, those who downplay or deny the differences between the Misesian and Hayekian positions on the socialist calculation debate) in regards to the correct understanding of the problem of socialism. This issue of course is also critical, due to the importance that a correct understanding of the problem of socialism has for the study of society as a whole. Leland Yeager highlights several areas

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where this is true, including economic theory, the history of economic thought, and twentieth-century economic history (Yeager 1997).

The paper is organized into four sections. The first section outlines the well-known arguments concerning the problems of socialism by Hayek and Mises. Section two outlines and assesses the arguments put forth by SRH. The third section identifies common ground for facilitating "bridging" the principal differences behind the controversy. A final section offers some concluding remarks.

Mises's and Hayek's Analyses of the Problem of Socialism

Because the "controversy" originates from differences in the interpretation of Hayek's and Mises's positions on the problem of socialism, it is important to begin by outlining these respective positions. As is well known, Mises's and Hayek's positions on the problem of socialism can be traced back to a handful of publications written between 1920 and 1940 in opposition to the generally held view of the time that socialism was a viable option of economic organization. In broad terms, Mises and Hayek argued that in the absence of free markets and private ownership of capital and land, a central planning authority would be unable to make efficient resource allocation decisions.

Mises's Arguments

Mises provided two major arguments for why a central planning authority would be unable to make efficient resource allocation decisions. These were described in his renowned article "Economic Calculation in the Socialist Commonwealth" (Mises 1935) and reemphasized in his later writings (for example, see Mises 1996 and 1969).

The first argument was concerned with the lack of incentives provided in a socialist society for people to act economically. Specifically, Mises argued that the lack of private ownership of capital and land in the socialist state would provide people with less of a reason to act responsibly and to take on initiatives. Mises referred to this as a lack of "commercial-mindedness" in the socialist state. Commercial-mindedness can, according to Mises, not be replicated by central planners. He writes:

> commercial-mindedness is not something external, which can be arbitrarily transferred. A merchant's qualities are not the property of a person depending on inborn aptitude, nor are they acquired by studies in a commercial school or by working in a commercial house, or even by having been a business man oneself for some period of time. The entrepreneur's commercial attitude and activity arises from his position in the economic process and is lost with its disappearance. (Mises 1935, p. 120)

Thus, the first problem stressed by Mises is primarily an implication of the institutional incentive structure provided in the socialist state (or lack thereof).

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The second problem stressed by Mises is a result of the inherent difficulties of determining monetary values of production-goods in the socialist state; according to Mises such values can only be provided in free markets where private ownership of capital and land are allowed. Without monetary values, it is, according to Mises, "impossible" for the human mind to calculate and/or process relatively complex "profit or loss" scenarios of production. Mises writes that this "requires rather more exact estimates and some judgment of the economic issues actually involved" (Mises 1935, p. 96). Thus, in Mises's view, monetary values provide guidance critical for individual decision-making. The problem highlighted by Mises is therefore derived from the notion that socialist economic planners do not have access to the necessary monetary values. These would therefore be restricted to making resource allocation decisions about production processes that "are relatively short and the expense and income entailed can be easily gauged" (p. 96). The implication that Mises draws from this is that the socialist state would remain at a relatively "primitive" state of development.

Hayek's Arguments

Hayek's arguments against socialism are less clear-cut than Mises's. This may be explained by the fact that they originally developed as an extension to Mises's arguments and then developed over an extended period of time. But in principle, Hayek provided two major arguments. The first was developed in direct response to a set of articles, published by mainstream economists, aimed at refuting what is referred to as Mises's "calculation" argument (i.e., the latter of Mises's two arguments mentioned above) (Kirzner 1987). In essence, these had argued, contrary to Mises's position, that prices need not be provided by the market in order to provide guidance, but could be provided by nonmarket prices announced by the central authorities, and treated by socialist managers in the same way that prices are treated by producers in perfectly competitive factor and product markets.[1]

In response to this argument, Hayek published three articles that specifically addressed the "calculation" problem diagnosed by Mises. In these, he argued that even if, as alleged by mainstream economists, it would be possible to collect all relevant data, the problem of socialism would still not be solved (Hayek 1948d, 1948e, 1948f). The reason for this, according to Hayek, is due to "the nature and the amount of concrete information required if a numerical solution is to be attempted and the magnitude of the task which this numerical solution must involve in any modern community" (Hayek 1948e, p. 153). According to Hayek, the amount of information needed to

[1]See especially Lange (1936), Dickinson (1933), and Lerner (1934). It should be noted that these economists only addressed the latter of Mises's two arguments.

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make the result at least comparable with that which the competitive system provides would exceed the power of algebraic analysis (Hayek 1948f).

The second argument raised by Hayek did not surface until a couple of years after his original argument had been made, and it was raised in what is often referred to as Hayek's knowledge articles (Hayek 1948b, 1948g, 1948c). In these, Hayek completed the argument he had started by also refuting the assumption that a central planning authority would indeed be able to collect all relevant data. To do so, Hayek emphasized the importance of knowledge in society (see esp. Hayek 1948g).

Knowledge, according to Hayek, provides the data from which the economic calculus starts. However, this data cannot be captured by a central planning authority because it is not readily available. It is to a large extent dispersed over time and place, i.e., private knowledge that depends on particular circumstances. Hayek writes:

> the knowledge of the circumstances of which we must make use [to calculate] never exists in concentrated or integrated form but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess. (Hayek 1948g, p. 77)

The real problem of the socialist society then, according to Hayek, is "that the 'data' from which the economic calculus starts are never for the whole society 'given' to a single mind which could work out the implications and can never be so given" (Hayek 1948g, p. 77). Thus, in Hayek's view the problem of socialism is primarily rooted in the ignorance or lack of knowledge held by the central planning authority.

The Recent Controversy: Arriving at a Distinction

It is in regards to the above-presented arguments that SRH have sought to draw a distinction between Hayek and Mises. While it has never clearly been laid out how SRH arrived at this distinction two key propositions appear to lay the basis for this position. First, that Mises's calculation argument had sufficiently diagnosed the problem of socialism, prior to Hayek's entrance into the debate. And second, that Hayek's analysis of the problem of socialism as being rooted in the lack of knowledge held by central planning authorities does not necessarily constitute an obstacle for the workings of the socialist state. The following provides a possible explanation of how SRH arrived at these propositions and how they allowed them to draw a distinction between Mises and Hayek.

SRH and Mises's Analysis of the Problem of Socialism

SRH's view that Mises's calculation argument had sufficiently diagnosed the problem of socialism, prior to Hayek's entrance into the debate, represents the least controversial issue in the controversy. SRH holds this view based on

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the significance that Mises attributes to the role of the appraisement process in economic calculation. This process is defined by Salerno as the

> process of the market transforms the substantially qualitative knowledge about economic conditions acquired individually and independently by competing entrepreneurs, including their estimates of the incommensurable subjective valuations of individual consumers for the whole array of final goods, into an integrated system of objective exchange ratios for the myriads of original and intermediate factors of production. (Salerno 1994, p. 112)

The significance of the appraisement process, according to SRH, in Mises's diagnosis of the problem of socialism is that it gives explicit recognition to Mises's position that the problem of socialism is ultimately rooted in the socialist state's inability to cope with change (i.e., to cope with economic dynamics). According to Mises, economic calculation incorporates such change by means of entrepreneurial foresight. That is, entrepreneurs anticipate and calculate profit and loss scenarios based on individual subjective judgments and past prices. The aggregate effects of these individual valuations are then transformed into objective prices that represent the market participants' aggregate anticipations of expected facts (i.e., the appraisement process). Because economic calculation incorporates entrepreneurial foresight it is, according to Mises, intimately bound with certain social institutions that cannot be replicated in the socialist state. Salerno (1994) correctly identifies these institutions as the division of labor and private ownership of the means of production, and Rothbard (1991, pp. 52-53) refers to them as "the existence of a market in the means of production, a market that brings about money prices based on genuine profit-seeking exchanges by private owners of these means of production." Hence, SRH's position that Mises's calculation argument sufficiently diagnosed the problem of socialism derives from Mises's insight that the problem of socialism concerns private property rights, because these enable the appraisement process to effectively incorporate change.

SRH and Hayek's Analysis of the Problem of Socialism

That the appraisement process is a crucial part of Mises's diagnosis of the problem of socialism should come as no surprise to people familiar with Mises's writings. What has caused confusion in this controversy, however, is that it appears to have constituted the core of SRH's argument for drawing a distinction between Hayek's and Mises's respective explanations of the problem of socialism. Again, the significance of the process of appraisement in drawing such a distinction is, according to SRH, that it gives recognition to the fact that economic calculation requires entrepreneurial insight (i.e., it is performed not only with consideration to current prices, but also based on expectation about future prices).

While it was never clearly explained by SRH how the appraisal process justifies a distinction between Hayek's knowledge argument and Mises's calculation argument, Salerno provides strong indications that the underlying logic

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for this position is based on a view of Hayek as a static equilibrium-theorist. The most explicit illustration of this is provided in a reply by Salerno to a challenge made by Leland Yeager in 1994 to further explain the alleged distinction. In this reply, Salerno explains that the failure of Yeager to distinguish between calculation and knowledge can be attributed to the reliance that "Yeager, Hayek and equilibrium theorists of all stripes" attach to proximal equilibrium (PE). According to Salerno, the process of appraisement is unnecessary in a state where proximal equilibrium has been reached. He writes:

> with the economy always in PE and current prices therefore conveying to producers virtually complete knowledge about relevant economic conditions in the present and the future, the only function that remains for entrepreneurs is to robotically compute revenue and cost functions and allocate resources so as to equate MR [marginal revenue] and MC [marginal cost]. Since the acquisition and use of knowledge is thus presented as the essence of economic calculation, should the central planners somehow or other get hold of the same knowledge in the absence of a price system, the entrepreneurial computation problem could be easily solved by the methods of linear programming. (Salerno 1994, p. 118)

The question of whether Hayek and other fourth-generation Austrians were static general equilibrium-theorists has also been the subject of more recent articles by Salerno. In these, Salerno holds his original argument but provides additional detail as a basis for the distinction, deriving the view of Hayek as a static general equilibrium-theorist from the influence Wieser had on Hayek, referring to Wieser as a "verbal" general equilibrium-theorist (Salerno 1999 and 2002).

Thus, based on this passage it is possible to understand the logic behind SRH's distinction. In essence, they argue that in a world of near equilibrium, present prices, or rather prices that have been realized in the immediate past, can serve as roughly accurate guides for future-oriented production decisions because there is no genuine uncertainty and therefore the entrepreneurial appraisement process is rendered pointless. Consequently, they refute Hayek's explanation of the problem of socialism based on the argument that the possibility that all relevant information could be collected and conveyed to a central authority cannot be precluded when an economy operates in close proximity to equilibrium. Hence, SRH's referral to Hayek as a proximal equilibrium-theorist (in other passages this reference to Hayek is synonymously used, by SRH, as "near-equilibrium-theorist") is in all-important respects equivalent to a view of Hayek as a static equilibrium-theorist (i.e., the economy has reached its final state of rest, and does not merely operate in close proximity to it). In their view, it is therefore only Mises's explanation of the problem of socialism that sufficiently challenges the possibility of socialism, through the explicit attention that he gives to the role of the entrepreneur in the appraisement process.

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Interpreting Hayek: A Dynamic- or a Proximal-Equilibrium-Theorist?

Considering SRH's view of Hayek as a static equilibrium-theorist, it is important to ask if this is a view that may be justified. The answer to this question is dependent on the specific approach chosen to interpret Hayek's writings. This section illustrates how an interpretation of Hayek's writings based on "textual" evidence, may be used to justify a view of Hayek as a static equilibrium-theorist. The section also emphasizes, however, that based on a broader interpretation of Hayek, it is difficult to deny that his primary interest was focused on the dynamic character of economic organization (or societal organization, later on in his career).

Arriving at a Static Interpretation of Hayek's Writings

It is well known that Hayek makes numerous references in his knowledge articles to the existence of a "tendency toward equilibrium," which is indicative of his interest in the dynamic character of economic organization (see esp. Hayek 1948b). However, Hayek never explicitly defines the magnitude or proximity by which this tendency transpires in relation to a full state of equilibrium. As a result, one may argue that the tendency toward equilibrium, proposed by Hayek, transpires in very close proximity to a full state of equilibrium. In fact, at the extreme, one could argue that it transpired in such close proximity that it is indistinguishable from a full state of equilibrium. This interpretation would lend a hand to justify SRH's definition of proximal equilibrium (or "near equilibrium"), as being close to equivalent to that of static equilibrium. The distinction drawn by SRH between Mises's and Hayek's respective positions on the socialist calculation debate may therefore be traced to a view of Hayek as a near-equilibrium or "proximal"-equilibrium theorist. That is, Hayek is viewed to conceive the economy as always operating sufficiently close to a final or a static state of equilibrium, so that present (i.e., immediately past) prices contain all the information necessary to guide producers in making optimal resource allocation decisions, thus, providing for a future that is not very unlike the present. For this reason, SRH argues that Hayek (unlike Mises) does not emphasize the indispensability to rational resource allocation of a dynamic entrepreneurial appraisement process operating under uncertainty that involves forecasting future market data and appraising future output prices on the basis of these qualitative and fallible forecasts.

"Textual" evidence is also available to support the SRH interpretation of Hayek's view of the market. For example, many of the key statements in Hayek's knowledge articles provide explicit support for such a view of Hayek. Throughout the controversy, SRH brings attention to several of these, including a statement from Hayek's article the *Use of Knowledge in Society*. Hayek writes: "The mere fact that there is one price for any commodity . . . brings about the solution which (it is just conceptually possible) might have been

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arrived at by one single mind possessing all the information" (cited in Salerno 1994). Taken literally this statement alleges that commodity prices reflect all information, a scenario which, of course, is only possible if the economy has reached its final state of rest. Hence, part of the controversy may be attributed to the inclusion of readings. A large part of the arguments brought forward in the debates, however, de-emphasize Hayek's later writings on the broader issues of social order and progress, which emphasize "discovery" and "learning."

When reading Hayek in a broader context, the view of Hayek as a static equilibrium-theorist becomes harder to accept. In his later writings, Hayek frequently gives explicit attention to the importance of dynamic concepts such as "learning" and "discovery" in explaining societal progress (see, Hayek 1979b; 1979c; 1973, pp. 114-16). As is well known by Hayekians, "learning" and "discovery" represent the building blocks of Hayek's explanations of what brings about societal "order." According to Hayek, in the absence of order (i.e., institutions), societal progress would not occur because people would be unable to satisfy their basic needs. Satisfaction of these needs serves as a prerequisite for people to be able to cope with "novelty" and novelty is required for societal progress to occur.[2] Thus, if emphasis is turned toward these later writings, Hayek is more likely to be perceived as a dynamic equilibrium-theorist (or more correctly, Hayekian equilibrium will be perceived as dynamic).

Bridging Differences

Considering the important historical role of theories on economic organization in Austrian economics, it is important that the above controversy is resolved. This paper makes a contribution to the controversy between SRH and those Austrians who downplay or deny the differences between the Misesian and Hayekian positions on the socialist calculation debate by identifying the issue of Hayek's equilibrium tendencies as an economic theorist as the central point of the debate. Given the discussion here and the extensive amount of high-quality writings that have been generated by Austrians on the subject of economic organization, there ought to be general consensus among Austrians on, at least, two issues, in regard to economic organization. First, that the problem of economic calculation is rooted in economic dynamics, and not in statics. And second, that if we allow for an interpretation of Hayek as a static-equilibrium theorist, it is indeed possible to refute Hayek's diagnosis of the problem of socialism and to draw a distinction between Mises and Hayek.

However, even if agreement on these two issues is reached and is sufficient to bridge the differences that resulted from the above-discussed controversy, a

[2]See Butos and Koppl (1993) and Lewin (1997).

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larger issue appears to be at stake. That is, to explain the value, from an Austrian perspective of viewing Hayek as a static-equilibrium theorist; an issue never directly addressed by SRH during the controversy. While an explanation of this issue goes beyond the scope here, it has the potential to refocus a controversy where the intellectual energy primarily was geared toward negative heuristics into something constructive. Such explanations seem important, particularly if one considers the long-run survival of Austrian economics as being dependent on its success in explaining economic and societal phenomena.

Final Remarks

This paper has attempted to bridge unresolved differences remaining from the Hayek and Mises "controversy," which materialized in the early 1990s. In achieving this, the paper sought to provide an explanation of how SRH came to interpret Hayek and Mises as distinct rather than complementary thinkers regarding socialism. It was argued that the distinction made is ultimately based on a view of Hayek as a near-equilibrium or proximal-equilibrium theorist. This means that Hayek conceives the economy as operating sufficiently close to a final or a static state of equilibrium, where present (i.e., immediately past) prices contain all the information necessary to guide producers in making optimal resource allocation decisions–an interpretation of Hayek that is in sharp contrast to Mises's view of the problem of socialism. It was also argued that while there is strong textual evidence to support the SRH interpretation of Hayek's view of the market, it de-emphasizes Hayek's later writings on the broader issues of social order and progress, which emphasize "discovery" and "learning."

The paper also points to the importance of focusing Austrian economics towards positive, rather than negative heuristics. In doing so, Austrians ought to take full advantage of both of Mises's and Hayek's many and excellent writings (and other Austrians). The focus on a too narrow aspect of these scholars' thoughts, such as those of Hayek's, holds the risk of resulting in unnecessary disagreements, among Austrians, as has been exemplified by the "Hayek and Mises Controversy."

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On the Optimum Quantity of Money

William Barnett II and Walter Block

It is pretty well established within Austrian economics that the optimum quantity of money is whatever level is established at any given time. The logical implication of this claim is that any amount of the commodity that intermediates trade will do as well as any other in acquitting this task. This being the case, there is no social or even private gain to be obtained by anyone adding to the money stock.

The present paper challenges this view, but from within the praxeological tradition. That is, we shall argue that although prominent Austrian economists have indeed made this argument, they are incorrect from their own basic perspective, which is shared in full by the present authors. Our thesis, in contrast to theirs, is that "more is better," or, more strictly speaking, at the very least it is possible that additional stocks of money can make a positive contribution to economic welfare.

Given that we are making a frontal attack on economists with whom we agree on virtually all other issues[1] in the dismal science, it behooves us to be very careful in documenting the charge we are about to bring. Accordingly, we quote quite fully from several leaders of the Austrian School, in order to obviate any possible misconstruction of their position.

But before we introduce our extensive quotations from Mises and Rothbard, for these are the economists against whose views we shall be contending, let us mention a possible misinterpretation of our own position, and attempt to obviate it.

William Barnett II is associate professor of economics at Loyola University New Orleans. Walter Block is the Harold E. Wirth Endowed Chair in Economics at Loyola University New Orleans.The authors wish to thank two referees of this journal for their comments on an earlier version of this paper.

[1]One referee commented, "What the authors [that is, us] fail to realize is that Mises's and Rothbard's hostility to the increase in the quantity of money was directed at its increase *by the government.*" This, indeed, might well have been the *intention* of Mises and Rothbard. However, as we attempt to demonstrate below, these two justly renowned economists did not always limit themselves to this concept, but rather exceeded it.

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According to this possible objection, we can be accused of attributing to Mises and Rothbard the view that any amount of *gold* in existence is an optimal quantity. That is, these two economists quite properly distinguish *money* from *gold*, even under a pure *gold* standard. Further, we might be interpreted as saying that it is not true that any given amount of *gold* in the economy at any given time is optimal. Very much to the contrary, if under free enterprise and a commodity standard gold mining occurs, and this adds to the stock of *gold* in contrast to money, then all is well, allocation wise.

This being the case, then, according to the critique that could be leveled at us, we are passing like ships in the night. Our correct thesis is not contradicting the correct analysis of Mises and Rothbard. Both claims can be true, since they do not contradict one another. That is, we claim that the optimal amount of *gold money* can possibly be increased with good effects, while Mises and Rothbard maintain that any increase in the stock of gold money is socially wasteful.

As against that, consider the following:

1. The optimal quantity of fiat money is zero (Hoppe, Hülsmann, and Block 1998, pp. 1-50). However, in a fiat-money-using society, the optimal quantity of fiat money is whatever is in existence, and, from an Austrian perspective, that quantity should never be changed, either increased or decreased, save for its complete elimination in shifting to a commodity money.[2]

2. Both Mises and Rothbard distinguish money from gold in that they both see the former as a subset of the latter; i.e., gold in teeth or jewelry, or for industrial purposes, etc., is not money; gold coins are money and, at least for Rothbard (1993, p. 169) "large bars of gold and silver have been used for storage or for exchange in larger transactions, while smaller, circular pieces, known as coins, are used for smaller transactions." Certainly commodity monies are included. To the extent Mises is saying that the extant quantity of fiat money should not be changed and it is socially wasteful to use scarce resources to add to the stock thereof, he is correct. However, to the extent he says that using resources (or goods in the case of conversion of the money commodity from nonmonetary uses to monetary uses) to increase the supply of monetary gold, e.g., any increase in the stock of gold money is socially wasteful, he is wrong in our view, as is Rothbard, who agrees with Mises on this, as we shall show.

Both are clear that using resources to add to the stock of a commodity money is socially wasteful; and both are clear that using resources to add to the stock of the money commodity is not socially wasteful *provided* that the increases in such stocks *are not* used for monetary purposes, but rather for their nonmonetary (tooth and jewelry) purposes. Other than as wallpaper or for numismatic purposes, fiat money has virtually no nonmonetary uses. We

[2]For Austrians, the crucial distinction is between commodity and fiat money, whereas for the mainstream it is that between real and nominal money (Friedman 1969, p. 1).

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are saying, in contradistinction to them, that it is *not* socially wasteful to use resources to add to the stocks of the monetary commodity regardless of whether such additions go to nonmonetary *or* monetary uses.

In sum, neither we nor they think that, except by sheer and temporary happenstance, the quantity of gold in the economy at any point in time is the optimal quantity; however, they are saying that the quantity of gold used as money at any given time is optimal, and we are saying that, if anyone voluntarily adds to the stock of gold used as money, that alone proves,[3] that the stock of monetary gold was not previously optimal. Thus, there is a real, not a semantic difference between them and us.

In section I we consider the evidence, section II is devoted to our critical analysis of Mises and Rothbard, and we conclude with section III, in which we consider several objections to our thesis.

THE EVIDENCE

In his *magnum opus*, *Human Action*, Ludwig von Mises states that

> The services money renders are conditioned by the height of its purchasing power. Nobody wants to have in his cash holding a definite number of pieces of money or a definite weight of money; he wants to keep a cash holding of a definite amount of purchasing power. As the operation of the market tends to determine the final state of money's purchasing power at a height at which the supply of and demand for money coincide, there can never be an excess or a deficiency of money. Each individual and all individuals together always enjoy fully the advantages which they can derive from indirect exchange and the use of money, no matter whether the total quantity of money is great or small. Changes in money's purchasing power generate changes in the disposition of wealth among the various members of society. From the point of view of people eager to be enriched by such changes, the supply of money may be called insufficient or excessive, and the appetite for such gains may result in policies designed to bring about cash-induced alterations in purchasing power. *However, the services which money renders can be neither improved nor repaired by changing the supply of money.* [Emphasis added] There may appear an excess or a deficiency of money in an individual's cash holding. But such a condition can be remedied by increasing or decreasing consumption or investment. (Of course, one must not fall prey to the popular confusion between the demand for money for cash holding and the appetite for wealth.) The quantity of money available in the whole economy is always sufficient to secure for everybody all that money does and can do.
>
> From the point of view of this insight one may call wasteful all expenditures incurred for increasing the quantity of money. The fact that *things which could render some other useful services are employed as money*

[3]We abstract, for argument's sake, from the possibility that this accretion was mistaken.

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> [emphasis added] and thus withheld from these other employments appears as a superfluous curtailment of limited opportunities for want-satisfaction. (Mises 1996, pp. 421-22)

Murray N. Rothbard, in his treatise, *Man, Economy, and State* restates and elaborates upon this position:

> Goods are useful and scarce, and any increment in goods is a social benefit. But money is useful not directly, but only in exchanges. And we have just seen that as the stock of money in society changes, the objective exchange-value of money changes inversely (though not necessarily proportionally) until the money relation is again in equilibrium. When there is less money, the exchange-value of the monetary unit rises; when there is more money, the exchange-value of the monetary unit falls. We conclude that there is no such thing as "too little" or "too much" money, *that, whatever the social money stock, the benefits of money are always utilized to the maximum extent.* [Emphasis in original] *An increase in the supply of money confers no social benefit whatever;* [emphasis added] it simply benefits some at the expense of others, as will be detailed further below. Similarly, a decrease in the money stock involves no social loss. For money is used only for its purchasing power in exchange, and an increase in the money stock simply dilutes the purchasing power of each monetary unit. Conversely, a fall in the money stock increases the purchasing power of each unit.
>
> David Hume's famous example provides a highly oversimplified view of the effect of changes in the stock of money, but in the present context it is a valid illustration of the absurdity of the belief that an increased money supply can confer a social benefit or relieve any economic scarcity. Consider the magical situation where every man awakens one morning to find that his monetary assets have doubled. Has the wealth, or the real income, of society doubled? Certainly not. In fact, the real income—the actual goods and services supplied—remains unchanged. What has changed is simply the monetary unit, which has been diluted, and the purchasing power of the monetary unit will fall enough (i.e., prices of goods will rise) to bring the new money relation into equilibrium.
>
> One of the most important economic laws, therefore, is: *Every supply of money is always utilized to its maximum extent, and hence no social utility can be conferred by increasing the supply of money.* [Emphasis in original]
>
> Some writers have inferred from this law that *any factors devoted to gold mining are being used unproductively, because an increased supply of money does not confer a social benefit.* [Emphasis added] They deduce from this that government should restrict the amount of gold mining. These critics fail to realize, however, that gold, the money-*commodity*, is used not only as money but also for nonmonetary purposes, either in consumption or in production. Hence, an increase in the supply of gold, although conferring no *monetary* benefit, does confer a social benefit by increasing the supply of gold for direct use. (Rothbard 1993, pp. 670-71)

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Rothbard then confuses the issue in a subsequent publication

> Thus, we see that while an increase in the money supply, like an increase in the supply of any good, lowers its price, the change *does not–unlike other goods–confer a social benefit.* . . . Our law–that an increase in money does not confer a social benefit–stems from its unique use as a medium of exchange.
>
> An increase in the money supply, then, only dilutes the effectiveness of each gold ounce; on the other hand, a fall in the supply of money raises the power of each gold ounce to do its work. We come to the startling truth that it *doesn't matter what the supply of money is.* Any supply will do as well as any other supply. The free market will simply adjust by changing the purchasing power, or effectiveness of the gold-unit. There is no need to tamper with the market in order to alter the money supply that it determines.
>
> At this point, the monetary planner might object: "All right, granting that it is pointless to increase the money supply, isn't gold mining a waste of resources? Shouldn't the government keep the money supply constant, and prohibit new mining?" This argument might be plausible to those who hold no principled objections to government meddling, though it would not convince the determined advocate of liberty. But the objection overlooks an important point: that gold is not only money, but is also, inevitably, a *commodity.* An increased supply of gold may not confer any *monetary* benefit, but it does confer a *non-monetary* benefit–i.e., it does increase the supply of gold used in consumption (ornaments, dental work, and the like) and in production (industrial work). Gold mining, therefore, is not a social waste.
>
> We conclude, therefore, that determining the supply of money, like all other goods, is best left to the free market. Aside from the general moral and economic advantages of freedom over coercion, no dictated quantity of money will do the work better, and the free market will set the production of gold in accordance with its relative ability to satisfy the needs of consumers, as compared with all other productive goods. (Rothbard 1990, pp. 33-35)

The Analysis

As is obvious from Mises's and Rothbard's statements (see particularly those we have emphasized), both are referring to a commodity money. In what follows, we restrict our comments to such money, and assume that in the free market gold coins would evolve as the money.[4]

[4]It is possible–even likely given historical experience–that the free market process might yield more than one money commodity, e.g., silver or copper, but this would not affect the analysis.

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Consider, then, the case of gold. As it does not affect the argument, let us consider only three uses for gold: as money in the form of coins; as jewelry, in the form of rings, etc.; and, as electrical contacts in electronic equipment. Although the total stock of gold available to human purposes could also be increased by the discovery of gold that had been available at some time in the past but then had been lost, we ignore such examples, as the analysis is not affected in any substantive way by examining only the case where additions to the stock of gold come from mining operations.[5] We assume that newly mined gold is immediately refined and formed into bullion, and such bullion is then sold for one of the three aforementioned uses.

If Mises and Rothbard are correct, then any additions to the stock of gold should be allocated only to uses as jewelry or as contacts. To allocate any to the third use, specifically, money, would be socially wasteful as it would yield no "social benefits" while there would be a cost associated with the non-use of any such gold for either of the other two uses.[6] Rothbard says that an increase in the quantity of gold money confers no social benefit, that any supply will do as well as any other, and that it doesn't matter what the supply is. This is necessarily erroneous. Gold has nonmonetary uses that do confer social benefits. Therefore, it does matter what the supply of money is: as little gold should be used for money as is possible and still have a quantity sufficient for it to retain the necessary characteristics a commodity must have if it is to serve as money. To use any gold beyond this bare minimum for monetary purposes deprives society of gold that could be used for socially beneficial nonmonetary purposes. Moreover, given his law that additions to the stock of monetary gold do not confer a social benefit but that additions to the nonmonetary stock do, it does not follow, as Rothbard says it does, that "the supply of money, like all other goods, is best left to the free market." Rather, it follows that the market should determine the supply of gold for nonmonetary purposes, but there should be a prohibition on socially wasteful additions to the stock of monetary gold. In other places, Rothbard recognizes that the free market *always* increases social welfare; e.g.,

> Economics, therefore, without engaging in any ethical judgment whatever, and following the scientific principles of the Unanimity Rule and Demonstrated Preference, concludes: (1) that the free market always increases social utility; and (2) that no act of government can ever increase social utility. (Rothbard 1956, pp. 252-53)

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[5]The stock of monetary gold could be increased by minting either newly mined gold or existing nonmonetary gold into coins. If the case can be made that no newly mined gold should be monetized, it follows, *a fortiori*, that neither should any existing nonmonetary gold be monetized, as that would require a reduction in the quantity of nonmonetary gold with attendant reductions in utility therefrom, something not required if newly mined gold is used for monetary gold.

[6]It must be noted that Rothbard's argument on pages 33, 34, and 35 of *What Has Government Done to Our Money?* is a *non sequitur*.

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This, however, brings us to the horns of a dilemma. Any *voluntary* increase in the stock of gold coins[7] from any source whatsoever, whether by minting newly mined gold into coins, or by converting gold already in use as jewelry or contacts into coins, will necessarily have one of two possible effects. Either, first, despite the fact that this will take place as a result of individuals going peaceably about their business engaging only in voluntary interactions with others, they would be utilizing scarce labor and other resources to add to the stock of money, which addition would have to be deemed by Mises and Rothbard as "socially-valueless." The difficulty, here, is that this would truly be a case of "market failure," a great bugbear of mainstream economics,[8] and something that Austrians have strived mightily to show as highly problematic (Cowen 1988; Hoppe 1989, pp. 167-86; Rothbard 1997a, 1997b).

Or, second, individuals would *voluntarily* choose not to mint additional coins from gold, whether newly mined or in use as jewelry or contacts; any additions to the stock of gold would be used only as jewelry or contacts, although gold could be reallocated between these two uses.

Certainly, in the first case governmental intervention into the market to control the money stock at whatever quantity is extant not only cannot be ruled out on principle, but as a matter of fact, is implied by the analysis; after all, if Austrians (e.g., Mises and Rothbard) are calling for an unchanging stock of the monetary metal, and this is changing purely through the activity of "capitalist acts between consenting adults" (Nozick 1974, p. 163), it is hard to resist the notion that the state must step in to overcome this supposed market imperfection. We are thus forced to arrive at the mainstream position with respect to "market failures"—one must weigh the costs of governmental intervention against the benefits thereof and intervene in cases where the latter exceeds the former. Nor will it do to note that costs and benefits are subjective—neoclassical economists maintain that we can and do use expenses and revenues as measures thereof (the present authors, of course, as Austrians, stipulate that they are attempts to measure objectively that which is necessarily subjective) (Barnett 1989, pp. 137-38; Buchanan and Thirlby 1981; Buchanan 1969; Mises 1996; Rothbard 1997a and 1993) in, for example, cases of tortious liability.[9] However, it is a certainty that neither Mises nor Rothbard

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[7]As to why one might wish *voluntarily* to increase the stock of commodity money, see the argument "the second case," p. 46, *infra*.

[8]It is unnecessary to document this claim, as it is practically the defining characteristic of neoclassical economics; consult any introductory or intermediate textbook—the distillation of the thinking of most practitioners of the dismal science, for confirmation.

[9]Although there is no subjectivist warrant for such cost-benefit analysis, it is absolutely required that the courts, whether they are governmental or an anarchist dispute resolution institution, undertake it, and, *to boot*, as an everyday occurrence. Judges do this, but not as scientists, rather as laymen, economically speaking. Take the case of A who causes B to lose a part of his body. Here, the courts are forced, willy-nilly, to determine

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would find a voluntary minting of newly mined gold into coins to be a "market failure."

Consider the second case. One would expect that in an even relatively-free enterprise society, over time there would be great increases in labor productivity and, probably, significant increases in population, the consequences of which would be vast increases in output. In such a situation, with a fixed stock of money, prices would tend to decrease continually. Eventually individuals would find that their gold, whether newly mined, or in the form of jewelry or contacts, would have such great purchasing power as money, that they would voluntarily mint gold into coins. Therefore, this scenario could not last indefinitely. That is, in a free society, eventually individuals would decide to add to the stock of money. The only way to prevent, or at least lessen, such a "socially-valueless" use of resources would be governmental intervention. In which event, see the analysis of the first case, above.

Moreover, the logic of the positions "[e]ach individual and all individuals together always enjoy fully the advantages which they can derive from indirect exchange and the use of money, *no matter whether the total quantity of money is great or small*" (Mises 1996, p. 421 emphasis added) and "[w]e conclude that there is no such thing as 'too little' or 'too much' money" (Rothbard 1993, p. 670)[10] implies that existing gold coins should be converted into use as jewelry or contacts. And, this conversion should continue so long as the benefits therefrom exceed the cost of conversion, bearing in mind that the reduction in the stock of gold money would, at some point eliminate one or more of the attributes requisite for a commodity to be money; e.g, divisibility, recognizability, and portability.

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what is the cost to B of this loss. In other words, sometimes we *must* quantify that which is inherently nonquantifiable, based upon technical praxeological considerations. Therefore, if "we" can do it in the case of torts, why not in the case of money? This holds particularly strongly if in fact we have correctly interpreted Mises and Rothbard as logically implying (even though they would of course not explicitly accept this characterization) that this is an example of "market failure." In such a case it would make just as much sense to say "we" need to do a "cost-benefit" study to determine if, and when, additions to the stock of gold money are warranted as it does to say "we" need to do a "cost-benefit" study to determine if we have the optimal level of good X, or have correctly hit upon the true costs to B of the loss of his body part. Therefore, unless we are prepared to agree to that proposition, and accept the concept of "market failure," including its application to gold money, it is difficult to see how the Misesian-Rothbardian position on this matter can be defended.

[10]Elsewhere, Rothbard modifies this position: "once a commodity is in sufficient supply to be adopted as a money, no further increase in the quantity of money is needed. *Any* quantity of money in society is 'optimal.' Once a money is established, an increase in its supply confers no social benefit" (Rothbard 1994, pp. 19-20). But this obviously supports the argument that any quantity in excess of this minimum is socially wasteful, given alternative valuable uses. This supports the (false) position that a voluntary increase in gold money in a free-market economy is a case of "market failure," and invites governmental intervention to correct the "problem."

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Why? This stems from the fact that if we go back in time far enough[11] to reach the period of barter, right before the advent of money, there was an occasion when gold was first used to intermediate trade, not merely as a valuable commodity on its own. At that point in time, the amount of gold used for this purpose was presumably minuscule. If so, then given Mises's and Rothbard's insistence that any amount of gold money will serve as well as any other, and there is no need to expand this supply (indeed, if this somehow occurs it is equivalent to a "market failure"),[12] then it logically follows that this teeny tiny amount of gold which was first used at the dawn of the creation of money should always suffice, even unto the present day.

Thus we again arrive at a fork in the road, facing two possibilities. First, the free market is inefficient, i.e., it allocates some of the new or extant gold to a valueless use as money, when it could and should have diverted it to a valuable use in jewelry or contacts, and this after first allocating other scarce resources to mining and refining, or to the conversion, thereof. Or, second, Mises and Rothbard are wrong. It staggers the (individualistic) mind to think that people would voluntarily commit valuable resources to the creation of socially-valueless goods.

Whence, then, the source of the value as money, if any there be, of the newly mined gold? (Its value in jewelry or contacts is obvious.)

The value of the new money would arise out of the additional transactions that would be made possible by its existence. That is, there would be transactions, previously impossible to undertake because the cost of using valuable gold to mediate such was excessive, which would now be made possible because the new monetary gold reduced the value of money at the margin. There are, at any time, a variety of potential exchanges. Some of these would create a great deal of value; others only a minute amount. The value that would be created by some potential exchanges is so small that the utility of gold in facilitating such exchanges would be less than its utility in nonmonetary uses. In such cases the potential exchanges would not occur.

As to whom might be hurt by an increase in the stock of a commodity money, by the very fact that it was voluntarily minted, it is certainly not the individual(s) who voluntarily minted it (save in the case of a mistake). Nor, again, by the very fact that they accepted the new gold money voluntarily could it be any individual(s) who voluntarily accepted it. No, the individuals "harmed" by such a voluntary minting of new gold coins would be those who own gold coins at the time and those who have financial assets denominated in terms of gold coins, such assets not being indexed for changes in the value of the coins. But the same logic applies in those cases as it does in the cases

[11]We refer to the Austrian theory of the money regression here. See on this Mises (1963, pp. 409-10).

[12]The authors of the present paper have resolved never to employ that phrase in the absence of quotation marks.

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of other goods, as Mises himself proved in his pathbreaking *Theory of Money and Credit* (1971).[13] That additional gold money decreases the value of previously existing gold money, or assets denominated therein, is no more a problem (or whatever pejorative one wishes to use) for the free market than is any other case of an increase in a good causing a decline in the value of previously existing units thereof. The logic of seeing that as a problem is that we should never produce anything for, ultimately, all goods are substitutes for each other, and therefore, the production of any of them must reduce the value of others already extant. Moreover, if gold is voluntarily mined it is because it has value to someone. Unless we are to outlaw gold mining, it will be mined and the new gold will be put to some use. To the extent that this use is as money, the value of extant stocks of gold in other uses is not, *ceteris paribus*, decreased. Were the gold that otherwise would have been coined not so monetized, it would have gone into other uses which would decrease, *ceteris paribus*, the value of the existing stocks of gold in those other uses. Furthermore, monetary gold can always be demonetized if the owner thereof values it more in a nonmonetary use.

Moreover, to quote Rothbard (1983, p. 38), to the extent that newly coined gold money becomes part of the supply of credit, unlike "bank credit expansion [that] *distorts* the market's reflection of the pattern of voluntary time preferences[,] the gold inflow *embodies changes* in the structure of voluntary time preferences."

The optimum quantity of money is not, then, whatever quantity happens to exist, but rather whatever amount of gold as coins the free-market process creates. As long as mine owners can unearth gold at a sufficiently low cost to make it worthwhile, and minters outbid those with other potential uses for at least some of the new gold, the money stock should be, and is, increased. Further, even in a situation where the cost of mining gold was not sufficiently low to make it worthwhile, and therefore there were no additions to the total stock of gold, if people's subjective values changed so that they placed a reduced value on gold in its nonmonetary uses or greater value on gold in its monetary use, and therefore withdrew some of it from nonmonetary uses and caused it to be converted to monetary uses, the stock of money again should be, and is, increased. In appropriately reversed circumstances, the money stock should be, and is, decreased.

We see, then, that, contrary to Mises and Rothbard, the quantity of money available in the whole economy is not always sufficient to secure for everybody all that money does and can do. Rather, the optimum quantity of money, as with any other good, is that quantity determined in the free market process, and, contrary to Mises and Rothbard, when the free market process causes additions to be made to the stock, such additions do confer a social benefit, in the form of additional voluntary exchanges facilitated.

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[13]See also Salerno (1994, pp. 71-115).

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OBJECTIONS

In this, our concluding section, we consider several objections to our thesis, and offer replies to them.

1. Even the teeny tiny amount of gold which first erupted onto the market as money at the close of the barter system would be sufficient to undergird all transactions. Therefore, there are no social benefits to increasing the amount of gold used for monetary purposes. One way this could occur—an "infinitesimal"[14] amount of gold sufficing for all trade—is through the intermediation of silver and copper. But even in their absence, gold, too, could do it, even in this minute amount. This could be accomplished if that minuscule amount of gold money came to be extremely valuable, or, what is the same thing, if prices in terms of this monetary commodity were very, very low.

It is true that this infinitesimally small amount of gold could intermediate all of modern trade, but it could not do so *efficiently*. If it could have done so efficiently there would have been no additions to the stock of gold money as such uses have non-zero opportunity costs. That is, this may be true, in the physically possible sense; theoretically, an infinitely small mass of gold money could mediate an infinitely large number of transactions provided the prices of goods were sufficiently low in terms of gold money (e.g., all of New York, Tokyo, and London would be sold for a teeny tiny fraction of a grain of gold).[15] But, that would not happen for economic (i.e., praxeological) reasons. This is because it would not be efficient. The source of the inefficiency would be increased transactions costs and the form would be forgone exchanges of such minute value that the increased transactions costs would preclude them. Note that as the limited initial quantity of gold money were to be used to mediate an ever greater number of transactions, the value per mass unit of this monetary gold would increase toward "infinity" (imagine if all of the transactions of 2000 A.D. had been mediated by 1 kg of gold money, what each atom thereof would have to have been worth. With gold that valuable it would not pay to use it to mediate transactions that increase value only a tiny bit. Moreover, we would be back to "market failure," for, surely, as gold's monetary value increased greatly, existing nonmonetary gold would be converted to, and new additions to the gold stock would be put to, monetary uses. Were this

[14]Infinitesimal is used herein to refer to the minimum quantity sufficient for gold to retain the necessary characteristics a commodity must have if it is to serve as money.

[15]In the limit, the lowest possible price of a good, x, would be one atom of gold per x. No lower price would be physically possible, as one atom is the smallest possible quantity of gold.

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not the case, the original piece of gold money would still suffice and the entire rest of stock could, and *indeed* would, be put to valuable monetary uses.

2. This is not a praxeological issue but rather one having to do with chemistry. The correct way to interpret the benefits of increasing the amount of gold used for monetary purposes is that it saves us from undertaking heroic chemical costs. That is, with a teeny amount of gold available today, all that could be spared for even the most valuable coin would be a relatively small number of atoms, and that is beyond our technological capabilities.

Whether it is the knowledge problem or the resource cost of trying to handle such infinitesimal quantities, or both is immaterial. Can you imagine the cost of trying to deal with coins of fractional-grain mass? And, yet, with gold so valuable in such small masses, most people would likely want physical possession thereof. It would no more do to keep records of transactions without physical media than it has been in the past or does today. And, imagine what would happen with an even partial run on the banks as has occurred recently in Argentina.[16]

Thus, just as it is costly to use other valuable resources to facilitate exchanges because they have alternative uses, so also with gold used in coins as money. This gold *also* has alternative opportunities, and its use as a resource to facilitate exchanges is not costless. Thus, gold will be used in the free market process to facilitate exchange only if, and to the extent that, such use is relatively more valuable than its alternative nonmonetary uses. The source, then, of the value of additions to the stock of money is the additional value-enhancing transactions that are made economical, and occur, because the additional gold decreases the value of money at the margin and therefore it can be put to less valuable uses whether as additional less value jewelry *or as a mediator of additional less valuable transactions.*

3. All this talk of chemistry, and coins with only atomic amounts of gold in them, is beside the point. It may have been relevant in a bygone era, but we now know that a gold standard can function quite adequately without, strictly speaking, placing some of this commodity in each and every single coin. Token or fiat coins can be used as an alternative, and this would obviate the need to "stretch" in effect what would be subatomic particles

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> Argentina has been struggling for months to prove to creditors that it can stay current on its $130 billion government debt. Fearing a default or a freeze on deposits, *Argentines have been pulling their money out of banks at a rapid clip.* Argentine officials say they'll use at least some of the new IMF aid to shore up the nation's financial system. (Druckerman 2001; emphasis added)

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of gold to all modern coins, if we were limited to the amount of this metal available when first it began to be used for money.

This solves one problem, that of "stretching" a minute amount of gold to cover all coins and bullion needed for modern commerce, but only at the cost of opening up a Pandora's box. It would take us too far afield to show why this scenario would not constitute a pure or 100-percent gold standard. Fortunately, this work has already been done and all we need do now is cite some of it (Block 1988, pp. 24-31; 1989; Block and Garschina 1996, pp. 77-94; Cochran and Call 1998, pp. 29-40; Hoppe 1990, pp. 55-87; Mises 1978).

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Conglomerates and Economic Calculation

Yoong-Deok Jeon and Young-Yong Kim

Using Mises's concept of economic calculation, this paper explains why conglomerates are frequently observed in emerging economies across the world. It also addresses the issue of why conglomerates take the form of either the multidivisional diversified single firm or the diversified business group. Here diversified business group is defined as an organizational form of production structure in which the parent company effectively owns and controls its affiliates whereas they maintain legal and accounting independence to a significant degree. We refer to this diversified business group as Conglomerate 1 in order to distinguish it from the multidivisional diversified single firm, named here Conglomerate 2. Both types of conglomerates exist along a continuum, from highly centralized to highly decentralized ones.[1] That is, the affiliates of Conglomerate 1 and the divisions of Conglomerate 2 may be centralized or decentralized to varying degrees.

We claim that conglomerates are created to solve the problem of economic calculation in emerging economies where markets are undeveloped or poorly developed. That is, they emerge as a production structure to overcome market imperfections, thereby reducing economic calculation costs. And the country's specific legal and political factors and regulations surrounding the business environments will determine the type of organizational form.

There are many theoretical studies on the reasons for the existence of conglomerates. Pankaj and Khanna (1998) neatly summarized the literature on the emergence of conglomerates. Khanna and Palepu (1999), among others,

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Yoong-Deok Jeon is a professor at the Department of International Trade at Taegu University in Kyungsan, Korea. Young-Yong Kim is a professor at the Department of Economics at Chonnam National University in Kwangju, Korea. We thank an anonymous referee for the helpful comments and suggestions. Financial support from the Korean Center for Free Enterprise is gratefully acknowledged.

[1]We thank an anonymous referee for this point.

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showed that conglomerates substitute for the institutions that support effective markets in capital, labor, and goods and services. Therefore, this study recasts their conception of market imperfections into the problem of economic calculation in explaining the existence of conglomerates in emerging economies.

The paper is organized as follows. Section I defines the conglomerate as a production structure, and characterizes its features. Section II presents the reasons for the existence of conglomerates, especially in emerging economies. It shows that the problem of economic calculation is a stumbling block in less developed countries, and a conglomerate is institutionalized to overcome this calculation problem. It also explains the emergence of a specific type of conglomerate, focusing on the case of Korea. Section III summarizes the advantages and disadvantages of conglomerates relative to stand-alone firms, and some concluding remarks are offered in the final section.

Conglomerate as a Production Structure

There are various production structures in an economy, which range from the market to a single independent enterprise. Long-term contract and subcontracting among firms are a production structure that lies in between the market and a stand-alone business enterprise. A conglomerate, whether it is the multidivisional single firm or the diversified group, is a more highly integrated one than the long-term contract and subcontracting. The production structures in an economy, therefore, could be arranged in a row from the market as the least integrated one, long-term contract, subcontracting, multidivisional diversified single firm/diversified business group, to a single independent firm as the most integrated one.

Conglomerates dominate the private sectors of most of the emerging economies. They abound in many countries such as Belgium, India, Indonesia, France, Hong Kong, Japan, Korea, Nicaragua, Pakistan, Philippines, Russia, Taiwan, Thailand, and so on.[2] Pankaj and Khanna (1998) reviewed the literature on the reasons for the existence of conglomerates in terms of (1) multimarket power, (2) related resources, (3) informational imperfections and entrepreneurial scarcity, and (4) policy distortions. They claimed that their case studies of the responses of two leading Indian conglomerates to the country's competitive shocks are in general consistent with a policy distortion view for the existence of business groups. In this study, however, we explain the reasons for the existence of conglomerates in terms of calculation problems resulting from market imperfections.

Some conglomerates are highly diversified across a wide line of business with many affiliated firms that maintain legal and accounting independence. They are predominantly owned and controlled by members of a family, and

[2]See Pankaj and Khanna (1998) for the list of the countries, though not comprehensive.

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financially interlocked.[3] Other conglomerates are also highly diversified across a wide line of business, but take the form of a multidivisional single firm. Concentrating on the issue of diversification, however, most previous studies did not articulate why a diversified business unit takes an organizational form of the multidivisional single firm or the diversified group. Unlike them, we also address this issue.[4]

There are two ways of creating a conglomerate. One way is that the parent company founds its divisions or affiliates in new markets through internal growth, and the other way to establish it is through the merger and acquisition of existing firms.[5] We primarily focus on the first type of conglomerate and treat the latter secondarily.

A Theory of Conglomerates

1. Business Environments in Emerging Economies

Despite the low standard of living, a relatively large demand exists for consumer goods in emerging economies. However, the markets are poorly developed at best, especially at the early stage of development, which makes production of goods and services through market transactions highly costly. Therefore, some entrepreneurs will find many potential opportunities to earn profits by establishing firms. At the initial stage, firms will be small. However, some of them will grow rapidly, accumulating a significant amount of financial capital on the availability of which the existing economic opportunities placed a premium.

As Papanek (1972) indicated, one crucial aspect of the growth of emerging economies as well as of the major firms that emerged is entrepreneurship of a vigorous, aggressive, and manipulative sort, which is characteristic of the initial phase of a private-enterprise economy.[6] This implies that some

[3]The outside experts and advisors have criticized this kind of extensive diversification and family ownership. For example, Korea's business groups, so-called *Chaebols*, were criticized as the culprit of the economic crisis of 1997, which, of course, is not based on sound theoretical and empirical grounds. Also, the executives of India's *Tata* group were recently advised by outside experts to concentrate on a few strong areas instead of extensive diversification. However, the executives determined to further diversify for several reasons.

[4]Leibenstein (1968), for example, pointed out that the entrepreneurs in the developing countries play a role as intermarket operators. However, his argument could not answer the question as to how the entrepreneurs in less developed countries make use of the multidivisional single firm and the diversified business group differently.

[5]The typical example of the former is the "Hyundai" group, and of the latter is the "Daewoo" group in Korea.

[6]For example, the representative entrepreneur in Korea, Byung-Cheol Lee, the founder of the "Samsung" group, could find great business opportunities in various unrelated industries.

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entrepreneurs have a strong incentive to establish a conglomerate. That is, as Garbor and Pearce (1952) pointed out, to maximize the net marginal return on capital, entrepreneurs are inclined to set up new firms in the same industry or to diversify into a new industry instead of increasing output until net marginal returns fall to zero by producing a single output. This also corresponds to Alchian and Demsetz's (1972) argument that conglomerates can be interpreted as an investment trust or investment diversification device.

In the process of forming a conglomerate, the internal capital market plays an important role in raising investment funds and allocating them to the efficient divisions or the affiliates.[7] At the early stage of industrial development, external capital markets are not well enough developed to raise enough financial capital to invest and do not function well in allocating it more efficiently than the internal capital markets (see, among others, Bhide 1990; Gertner, Scharfstein and Stein 1994; Stein 1997; Williamson 1975). Klein (2001) demonstrated that conglomerate diversification might have added value by creating internal capital markets. Given that entrepreneurs could take advantage of internal capital markets in raising funds for diversified investment, the question as to what type of production structure they would form still remains.

2. The Economic Calculation Problem

As Mises pointed out, every human action implies planning. And any planning needs economic calculation. Likewise, every organization plans and calculates. It needs price information, or market information for economic calculation. Without markets, no one can obtain market information, without which economic calculation is impossible or inaccurate. In this section, we show that the calculation problem would encourage the entrepreneurs in emerging economies to establish conglomerates.

Transaction cost and calculation cost

The Coasean (1937) theory of the firm suggests that it is profitable to establish a firm since there exists a cost of using the price mechanism. It implies that a firm is established to reduce the costs of making products through market transactions. Here the market transaction costs refer to those that a firm encounters in discovering the relevant market prices, and in negotiating and concluding a separate contract for each exchange transaction taking place on the market, and so on. By forming a firm, an entrepreneur who directs resource allocation within the firm can save certain market transaction costs. Because internal transaction costs increase as more and more market transactions are internalized into the firm, the entrepreneur decides whether a particular transaction should be done on the market or within the firm by

[7]In addition, poor development of commodity and labor markets also contributes to the emergence of conglomerates in emerging economies. See Khanna and Palepu (2000) on this point.

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weighing the market transaction costs against internal transaction costs. Therefore, a firm would grow until the marginal cost of a market transaction equals that of an internal transaction. That is, an optimum amount of planning exists within a firm.

Mises (1975 and 1996) showed in the calculation debate that socialism eventually breaks down primarily because of lack of price information on the means of production while the incentive system is also problematic. He argued that without private ownership of factors of production, especially capital goods, their market prices could not be available. Therefore, no decision-maker can evaluate the relative efficiency of various production techniques. Even the most dedicated entrepreneur cannot make judgments about the relative efficiency in allocating factors of production without market prices of capital goods even if he possesses all the information on consumer wants and preferences, state of technology, and so on. Consequently, Mises did not buy the "knowledge problem" raised by Hayek, and dismissed the possibility of market socialism that Lange (1936 and 1937) asserted. Mises suggested that socialism survived for quite a long while because it could use the market information of the capitalist economies.

Rothbard (1993, pp. 528-50, 573-79, 585-86) insisted that the calculation problem exists not only in a socialist economy but also in the determination of the size of the firm. He argued that external markets for intermediate goods or productive inputs are required for economic calculation of profit and loss of each stage. Rothbard put the costs of economic calculation as follows. "As the area of incalculability increases, the degrees of irrationality, misallocation, loss, impoverishment, etc., become greater" (Rothbard 1993, p. 548).

Rothbard claimed that the calculation costs play an important role in determining the upper bound of the firm size. As more and more market transactions are internalized into the firm, certain factor markets would gradually disappear. Thus, the firm will face the calculation problem since it cannot obtain market prices of those factors. Consequently, the firm cannot grow so that it reaches one big firm or one big cartel. This argument is a modified firm theory that can apply to a situation where markets are nonexistent or poorly developed, and complements the Coasian firm theory that well suits the situation in which markets are fully developed. In this connection, Rothbard (1976, p. 76) wrote:

> This point also serves to extend the notable analysis of Professor Coase on the market determinants of the size of the firm, or of the relative extent of corporate planning within the firm as against the use of exchange and the price mechanism. Coase pointed out that there are diminishing benefits and increasing costs to each of these two alternatives, resulting, as he put it, in an "'optimum' amount of planning" in the free market system. Our thesis adds that the costs of internal corporate planning become prohibitive as soon as markets for capital goods begin to disappear, so that the free-market optimum will always stop well short not only of One Big Firm throughout the world market but also of *any* disappearance of

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specific markets and hence of economic calculation in that product or resource.

Klein (1996) reviewed the literature on the calculation problem of Rothbard and pointed out that the theory of the firm suggested by Rothbard has long been neglected by academics.

To summarize, Coasian theory of the firm implicitly assumes that a firm can obtain all necessary price information on goods and services and factors of production on the market whereas Rothbard pointed out that this might not always be possible. It implies that Coase did not take into account the calculation costs resulting from the absence of factor markets. If markets are well developed, therefore, the firm size will be determined by the marginal cost of market and internal transaction with negligible calculation cost. However, as factor markets begin to disappear, three kinds of cost will increase, but in different fashion and degree. Consequently, the size of the firm will be determined at a point where the marginal cost of a market transaction is equal to the sum of a marginal cost of an internal transaction and the calculation cost. Based on this concept, we explain why conglomerates are established in emerging markets.

Calculation cost for diversified business unit in emerging markets

A conglomerate, whether it is the multidivisional single firm or the diversified business group, is not an exception to the problem of economic calculation. In fact, capital goods markets as well as other factor markets are poorly developed in emerging economies.[8] Let us examine a hypothetical example to help understand the problem of economic calculation. We note that the very basic idea of the example comes from Klein (1999, p. 27). Suppose that an entrepreneur owns and manages Firm A of which line of business is construction. And suppose that he discovers a new business opportunity, shipbuilding (Project B) for example, and potential demand for ships and the related factors is expected to be high.

If the market for ships and the factors of production were well developed, there would be no problem in internalizing the project into a division of a highly centralized single firm. No calculation problem would occur. On the other hand, if the markets are not well developed, a calculation problem occurs. Suppose that the founder-owner employs himself as the top manager of Project B, his opportunity cost of engaging in Project B cannot be precisely figured out since the market for managers is undeveloped. Without reference prices from the markets of factors of production, as Garbor (1984) and Eccles and White (1988) suggested, there might be two ways to estimate the opportunity cost. First, their transfer prices at each stage might be cost-plus basis.

[8]Koo (1993, pp. 31-32, 37), the former head of the "LG" group, has recalled that the markets for many final goods and productive inputs were nonexistent or poorly developed in the early development stage in Korea.

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Second, it might be determined according to the bargaining power of the selling and buying divisions at the adjacent stages. However, the estimated costs would be less accurate than the ones available from the market. This makes the economic calculation inaccurate, thereby resulting in lower organizational efficiency. Consequently, the entrepreneur-founder in emerging economies, though not perfect, could solve the calculation problem by internalizing Project B into a division of a single firm, each division having its own board of directors (Conglomerate 2). The divisions of a diversified single firm act as if they are external markets to one another and generate market information that can be used in the economic calculation of each division.

The second way for the entrepreneur-founder to solve the calculation problem is to establish new affiliates that are owned and effectively controlled by their parent company whereas the affiliates maintain legal and accounting independence to a significant degree, resulting in a diversified business group. The affiliates of a diversified business group may be highly or loosely centralized. In any case, the affiliates of a group, like the divisions of a diversified single firm each having its own profit center, act as if they are external markets to one another and generate market information.

In sum, there are two ways of solving the problem of economic calculation: a diversified single firm with multidivisions each having its own board of directors, and a diversified business group with affiliates maintaining legal and accounting independence. Although both organizations face some difficulties of economic calculation, they emerge as a vehicle of minimizing calculation cost.

Then a question arises as to why conglomerates develop through merger and acquisition and buyout of the existing firms, like the "Daewoo" group in Korea. The fact that there are existing firms might suggest that the external markets for factors of production have somewhat developed. But the factor markets are thin in that most of them are poorly developed with some markets for final goods being present. Under such circumstances, calculation costs still exist and are high. Thus the entrepreneur establishes a conglomerate in order to reduce the calculation costs.[9] In addition, a conglomerate is needed to compete with other conglomerates. That is, a conglomerate causes other conglomerates to develop.[10]

The last question to be answered is why some conglomerates take the form of a multidivisional single firm while others take the form of a diversified business group. As a referee pointed out, we claim that it depends upon

[9]In this connection, we conjecture that vertical and horizontal integration would occur if an increase in the sum of the internal transaction cost and calculation cost when integrated is less than the market transaction cost. Vertical and horizontal integration means disappearance of the related factor markets, which increases the costs of economic calculation.

[10]For example, large groups in Korea have competed for a long time in almost every industry.

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the country's specific legal and political factors and regulations surrounding business environments. In Korea, almost all conglomerates choose the diversified business group rather than the multidivisional single firm. That is, conglomerates in Korea diversify their line of business through affiliate expansion rather than divisional expansion. Hwang (2001, pp. 5-6) claimed that affiliate expansion helps the entrepreneurs to diversify because cross-equity investment allows them to obtain external funds. In fact, capital markets in Korea had been poorly developed and access to external funds had been limited. Affiliate expansion was a more efficient way for the diversified business units to increase their investment through cross-equity investment. Also, financial intermediaries required borrowers to guarantee their debts. Cross-debt guarantees between affiliated firms within a group had been a convenient way to conform to such implicit regulation. Thus we claim that the entrepreneurs used group-affiliated firms to expand their business to unrelated areas.

Moreover, allocation of indivisible inputs across divisions in a single diversified business firm may be problematic, but not with the affiliated firms. Calculation of overhead costs such as those for water, electricity, land, building, machines for general purposes, and administrative personnel, would be imprecise even if the market prices of those inputs were available. However, such a calculation problem will be easily overcome with the diversified business group.

The Advantages and Disadvantages of Conglomerates

Once a conglomerate is established, its affiliates or divisions are able to grow faster than unaffiliated firms. One obvious advantage is that conglomerates are able to accumulate know-how in saving calculation costs more than unaffiliated firms. Therefore, affiliates or divisions have a comparative advantage over stand-alone firms in economic calculation. In addition, group affiliates or divisions could enjoy the benefits of a conglomerate merger. Bork (1978, p. 249) summarized the various reasons for the benefits of a conglomerate merger. Also, as Marvel (1990) demonstrated, affiliated firms benefit from sharing information about foreign markets, thereby having a comparative advantage in foreign business.

Khanna and Palepu (1999, p. 133) reported that the average return on assets for group-affiliated firms was higher than that of unaffiliated firms over the most part of the last decade in Chile. Also group affiliates outperformed unaffiliated firms in Korea. Lee and Yoo (1994) found that, at manufacturing firm level, average gross sales revenue per person of affiliated firms was higher than that of unaffiliated firms in 1988. Also, the average value added per person of affiliated firms was greater than that of unaffiliated firms. Gong (1993a) presented a similar result to Lee and Yoo. The higher productivity of affiliates is reflected in their high growth rates. Gong (1993b, p. 76) showed that, in 1965, 87 unaffiliated firms and 13 affiliated firms with business groups were included in the largest 100 firms in Korea. In 1991, however, 79

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affiliated firms and 21 unaffiliated firms were included. Moreover, Chang and Choi (1988) provided the evidence that affiliated firms could enjoy more scale and scope economies than unaffiliated firms.

Finally, the difference in productivity between affiliated and unaffiliated firms might be negligible or not large at the beginning stage of forming a business group. However, efficiency of the affiliates would be enhanced as soon as diversification exceeds a certain level. Khanna and Palepu (2000) provided evidence from India that accounting and stock market measures of affiliated firms' performance initially declined with group diversification, but subsequently increased once diversification exceeds a certain level. These empirical findings show comparative advantages of affiliated firms over unaffiliated firms.

On the other hand, there are some reasons that conglomeration may give rise to costs. First, interests of the controlling family shareholders may not conform to those of minority shareholders. Second, common family ownership may result in the misallocation of capital. Third, conglomerates may employ inefficient compensation schemes across the affiliates or divisions for internal equity reasons. Fourth, the headquarter of a conglomerate may also make suboptimal decisions because it may face the difficulty of acquiring expertise in various unrelated areas. Finally, rent seeking by divisional managers (Scharfstein and Stein 2000), bargaining problems within the group (Rajan, Servaes, and Zingales 2000) or bureaucratic rigidity (Shin and Stulz 1998) can make cross-subsidization among the affiliates or divisions of a conglomerate inefficient. All in all, the existence of conglomerates in emerging economies should suggest that the benefits exceed the costs of forming conglomerates.

Concluding Remarks

Using both the transaction costs of Coase and calculation costs of Mises and Rothbard, this study explains why conglomerates have developed as a production structure in emerging economies. Coase showed that a firm is established to economize market transaction costs. But Rothbard claimed that market information may not always be readily available, thus the cost of economic calculation determines the upper bound of the firm. We claim that conglomerates are created as an efficient organizational form to solve the problem of economic calculation in emerging economies where external markets for productive factors are poorly developed. That is, conglomerates originate as an organizational form of production structure to overcome market imperfections. And the country's specific institutional and political factors and business regulations will determine the specific form of the conglomerates: the multidivisional single firm or the diversified business group.

An important policy implication of the present study is derived as follows. The importance of conglomerates will diminish as the markets for factors of production are more and more developed so that calculation costs are

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significantly lowered or eliminated. However, it would take a long time for the markets of final goods and factors of production to develop in any economy. Chandler (1977) reported that, in the United States, modern business enterprises evolved from their traditional form to the current one over the period 1840-1920. The history of business enterprise is relatively short in emerging economies, mostly less than 50 years. Thus, under current economic environments where factor markets are still developing, forced restructuring of the conglomerates by the government makes the production structure inefficient and blocks their evolution in the market. If conglomerates seem to be problematic for socio-political reasons, the best way for the government to resolve it is to establish infrastructures such as a legal system so that the markets can develop in their own way.

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REVIEW ESSAY

TOWARDS A NEW SOCIALISM? BY W. PAUL COCKSHOTT AND ALLIN F. COTTRELL. NOTTINGHAM, U.K.: SPOKESMAN BOOKS, 1993.

LEN BREWSTER

Short of state implosion, what those who wish to promote free markets most need is an unevasive, contemporary, socialist theory. A bird cannot fly without air resistance, and those who oppose planning, egalitarianism, and "democracy" cannot long be sustained by grudging consent, however wide, relieved only by pedantic disputes over the terms of agreement.

W. Paul Cockshott and Allin Cottrell in their book *Towards a New Socialism* supplemented by a number of substantial papers[1] (1993a, 1993b, pp. 71-99; 1993c, pp. 73-112; 1993d, pp. 157-85; 1997, pp. 177-302) have come as close to developing a serious, up-to-date version of a neo-Marxist political economy as we are likely to see. They propose that money be abolished, replaced by labor tokens, that these be equally (or nearly equally) distributed, that we voluntarily reorganize into communes, and that the State dissolve into a neo-Athenian democracy.[2]

In support of these proposals they claim to have refuted the socialist calculation argument, maintaining that such calculation is perfectly feasible using units of average socially necessary labor time (1993c, chap. 3-9, pp. 20-25). I believe they have succeeded in countering a version of the calculation argument thus ironically clarifying and strengthening the reasons for considering socialist calculation not just as troublesome, but impossible, and valuation in terms of labor an illusion.

Aside from a few sour remarks about democracy and equality, I shall confine myself to what Cockshott and Cottrell (hereafter C&C) have to say about socialist calculation.

[1]The book, these papers, and other studies are online at ecn.wfu.edu/~cottrell/socialism_book/ or dcs.gla.ac.uk/wpc/reports/ *or* reality.gn.apc.org/. Ensuing references will be to the online versions.

[2]Such novelties are discussed in *Towards A New Socialism* esp. chaps. 12 and 13.

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The Socialist Calculation Argument

We may summarize a version of Mises's argument as follows:

(1) Under capitalism problems of allocation and coordination of higher order goods are solved on a competitive market as it assigns monetary values to the various choices.

(2) Socialism must abolish the market at least as the principal mechanism by which such calculations are made.

(3) As the market is abolished, so must money be abolished.

(4) The only way by which calculation under Socialism might then be accomplished is by the use of units of socially necessary average labor time, themselves independent of the competitive market.

(5) Such units cannot be independent of the competitive market.

So, socialist calculation is impossible.[3]

This is but one version of the argument. Another interpretation takes the difficulty to be that the size and complexity of a modern economy puts the task of socialist calculation forever beyond our cognitive abilities. This is the version that C&C have refuted. The argument outlined above, on the other hand, purports to show, as C&C put it, that the calculation cannot be set up. The conclusion then is not just that socialist calculation happens to be too much for us, but that it is *logically* impossible–something that cannot be accomplished in any possible world, or by an omniscient, omnipotent God.[4] As they overcome the difficulty of socialist calculation C&C have, contrary to their intentions, allowed us to see more clearly its impossibility. For that service some future market anarchist community might erect their statues in the town square.

Mastering Scale and Complexity

The barrier to socialist calculation is commonly thought to be the size and intricacy of markets for second order goods:

> The real problem, as Mises has insisted from the beginning, is in all the intermediate markets for land and capital goods. Producers have to use land and capital resources to decide what the stocks of the various consumer goods should be. Here there are a huge number of markets where the State monopoly can only be both buyer and seller for each transaction, and these intra-monopoly, intra-state transactions permeate the most vital markets of an advanced economy–the complex lattice-work of the capital markets. And here

[3]Support for this interpretation can be found, for instance, in Mises (1990, pp. 33-34).

[4]A possible world semantics for modal propositions was perhaps first suggested by Leibniz, and developed for modern logic by Saul Kripke. See, for instance, Leibniz (1976, p. 263) and Kripke (1971, pp 62-73).

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> is precisely where calculational chaos necessarily reigns, and there is no way for rationality to intrude on the immense number of decisions on the allocation of prices and factors of production in the structure of capital goods. (Rothbard 1991, pp. 56-57)

It is certainly true that the sheer complexity of a modern economy would hardly permit comprehensive planning to be trivial. But how disappointing to witness "an impossibility" deflate into an unmanageable difficulty! Fortunately, C&C show that the difficulty is no longer unmanageable, thus leaving us with, if anything, the impossibility.

Since I do not contest the issue, there is little reason for more than the barest outline of the argument.

Given a modern economy in which millions of distinguishable goods and services are produced, the problem is to assign a cardinal ordering to these goods and services answering to consumer demand (C&C allow a consumer market) and to relative scarcity and abundance. Since demand and supply are in constant flux, our assigned values would have to change accordingly, and in such a way that economic activities were timely and in proper sequence.

The problem is not just one of scale, but of interconnection since some of these goods and services are inputs for others and thus in part must determine their value.

C&C acknowledge that the market solves this problem:

> It is clear that market prices do provide a basis for calculation under capitalism: by reference to prices, firms are able to decide on cost-minimizing technologies, and to decide between producing different products on the basis of their profitability. And we don't feel any need to dispute Mises's claim that the price system provides for a reasonably effective coordination of economic activities. Neither would we care to assert that the minimization of monetary cost of production or the maximization of profit have nothing to do with achieving efficiency in the satisfaction of human wants. (Cockshott and Cottrell 1993c, p. 9)

Aside from whether the market solution is unfair, costly, and inefficient (C&C think it is all three) is there an alternative?

If we could find units of value truly independent of the market, and if such units could serve as a basis for economic calculation again independent of the market, then, it would appear that size and complexity alone would not prevent socialist calculation.

Assume, as do C&C, an economy which generates 10^6 distinguishable goods and services. A Leontief input/output matrix for such an economy would then need solutions for $10^6 \times 10^6 \times 10^6 = 10^{18}$ equations to eliminate the variables assuming everything to be an input for everything else. Each equation, furthermore, might require 10 elementary computer instructions. The running time for obtaining an exact solution to such a problem would be proportional to 1018. Even though super-computers such as the Fujitsu VP200 and the Hitachi SS10/20 can perform something like 20 million arithmetic operations per second, the time required to solve such a set of equations would be about 16,000 years. However as C&C point out, not everything is an input for everything else (cheese is not made from chalk), and so, many, indeed most, of the equations could be eliminated (pp. 49-50).

Furthermore, we would not need a one-shot exact solution, but could well settle for approximations to any degree of precision. They suggest that the first approximation could be obtained using only direct inputs. The second would take as a baseline the first approximation using second-order indirect inputs, etc. (p. 50).

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They conclude:

> The time order complexity of this algorithm is proportional to the number of products times the average number of inputs per product, times the desired accuracy of the result in digits. On our previous assumptions this could be computed on a computer in a few minutes, rather than the thousands of years required for Gaussian elimination. (p. 50)

The short time required for the computation suggests that planners might be in a position to keep up with changes in demand for outputs and variability in the relative scarcity of inputs at least as well as the market, thus weakening another objection to planning often associated with Mises's argument to the effect that no dynamic solution is possible (1993c, pp. 24-25).

Whether the planners could keep up with the changes in the economy depends, however, not just on their ability to do the sums quickly, but, as important, on their access to the required information.

According to C&C, the information needed for planning might be readily accessible through the telecommunication systems already at hand if only such information were not treated as a form of private property:

> All this effort (insuring restriction) is necessary because information is treated as private property. It is a strange sort of property in that it can be stolen and remain where it is intact at the same time. Indeed it could be argued that information is not by nature suited to be property since it is so easily copied and so difficult to protect. Nevertheless the computer industry has grown up around the notion of protecting and hiding information. To establish the free and open flow of information demanded by a rational planning system will require not only the legal abolition of commercial confidentiality, but also the redesign of most of the installed computer software currently in use. (1993a, p. 112)

"An economy-wide network of cheap personal computers, running spreadsheets representing the conditions of production in each enterprise in conjunction with a national Teletext system and a system of universal product codes" (1993c, p. 22) would enable managers to transmit information about demand and the availability of resources far more rapidly and efficiently than the market as such information would no longer be encumbered by the actual movement of goods (p. 6).

C&C are of course aware that there has been a well documented tendency for this style of information retrieval to generate systematically distorted data. Motivated by a desire for an easy life or imperial ambitions, managers in the former Soviet Union persistently overestimated the quantity of needed inputs.

Why would C&C's scheme be immune? Their answers are not reassuring,[5] (1993a, pp. 114-17) but whether you can keep managers from gaming the system is not a question peculiar to socialist planning, and anyway it is entirely separate from whether such planning is technically feasible.

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[5]They suggest comparing market prices to quantities of socially necessary labor time as a way of sniffing out inefficiencies. This would entail imputing costs to second order goods from the consumer market, which is problematic, and seems to give up on any genuinely socialist remedy.

They go on to mention alternative incentives like those that urge Mises, Hayek (and presumably Marx) to write their books and which might inspire desirable economic performance. Anyone who has ever attended a writer's forum, a professional meeting, or faculty conference might doubt the net gain.

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Indeed, so far as it turns on whether the sheer size and complexity of a modern economy, C&C have, I believe, shown that socialist planning is possible. This is a happy outcome. Who, after all, could rejoice in the discovery of an inherent human incapacity?

PLANNING VINDICATED?

C&C argue that an objective guage of economic value would be much superior to subjective valuations reflected in market prices. Objective valuation would not be arbitrary and thus vulnerable to absurd caprice. In the form of socially necessary labor time, planning efforts would be directed toward economizing labor rather than money, thus encouraging invention and innovation. This would in turn greatly enrich human welfare by allowing more time for leisure and cultural activities. And, of course, by identifying economic value with that which supposedly creates it, exploitation is discouraged or even eliminated, and equality is presumed.

In sum, the case for using labor time as an objective measure of economic value is that as things stand this would direct economic activity toward improvement of people's lives:

> We could in principle measure costs in terms of any widely used resource. In an industrial economy we might reasonably price goods in terms of the energy that went into their production. If society faced overriding constraints upon the amount of energy that it could use, perhaps for environmental reasons, then this might be a good way to price things. We advocate using labor time as the basic unit of account because we think that society is about people, and for the moment at least, how people spend their lives remains more important than any one natural resource. (Cockshott and Cottrell 1993a, p. 45)

Just as consumer preference can only be objectified in market prices, labor can only be objectified as time expended. More particularly this must be expressed in relation to the average time it takes within a given community having a certain political and economic organization and possessing a characteristic technology to produce at a certain minimum level of quality a good or a service for which there is sufficient demand to cover costs.

Since what would be measured here is average clock time and deviations from it, we can determine not just more or less, but, just as in monetary measurement, how much more or less. Their cardinality certainly makes units of socially necessary labor time more plausible as a basis for socialist calculation than comparisons in nature as suggested for instance by Neurath[6] (Mises 1990, pp. 23-26; Hoff 1981, pp 75-80; Steele 1992, pp. 123-27). So, there would appear to be no technical reason why such units could not figure in the method of economic calculation already briefly described.

Should labor time not make economic sense, none of this is to any avail. C&C attempt to answer with varying success the objections to the economic rationality of labor time as the basis for economic calculation (Cockshott and Cottrell 1993a, pp. 23-29; 1993b, pp. 6-9, 22-25). I will notice only one of these problems and C&C's attempted solution.

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[6]One of the glories of the internet is you can now find people who take even calculation in kind seriously.

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Calculation in labor values does not factor in demand. And with apologies to Kant it appears that on any economic theory, supply without demand is blind and demand without supply futile.

C&C attempt to introduce demand into their scheme by resorting to what they characterize as a moneyless "market of sorts." Labor certificates would be distributed to members of the commonwealth testifying to the number of hours they had worked or their entitlement. These certificates could only be used to purchase consumer goods, and would, like theater tickets be cancelled against such purchases. (C&C 1993a, pp. 24-25).[7]

C&C describe the operation of this quasi-market:

> The central idea is this: the plan calls for production of some specific vector of final consumer goods, and these goods are marked with their social labor content. If planned supplies and consumer demands for the individual goods happen to coincide when the goods are priced in accordance with their labour values, the system is already in equilibrium. In a dynamic economy, however, this is unlikely. If supplies and demands are unequal, the "marketing authority" for consumer goods is charged with adjusting prices, with the aim of achieving (approximate) short-run balance, i.e. prices of goods in short supply are raised while prices are lowered in the case of surpluses. (1993a, chap. 8; 1993c, p. 20)

To guide the economy as a whole, planners would then note the ratio of the market clearing price in labor certificates to the labor content for all consumer goods. They cut back production of those goods for which the value of the labor content exceeds price, and increase production of those for which price exceeds labor content. The authority would have previously calculated the gross outputs sufficient to produce the targeted quantity and distribution of consumer goods thereby assuring that the plan is approximately in balance (C&C 1993a, pp. 82-86; 1993c, p. 24).

The planning board would now have the information they required to determine how much and what kinds of higher order goods need to be produced. The quasi-market would furnish them with gross demand in labor time for each industry. These figures would then be factored into first order, second order etc., inputs valued in labor time. Calculations of the most economical inputs in terms of labor time might then be made, taking advantage of the simplifying factors mentioned before: not everything is an input for everything else and there is no need and in fact no possibility in a dynamic economy for anything more than a solution refinable to any degree of approximation. The speed and efficiency of late model computers would assure that

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[7]As C&C point out:

> Nowadays one need not think in terms of paper certificates of work done. Instead we can envisage the use of some form of labour credit card which keeps track of how much work you have done. Deductions from your social labour credit account could be made by filling in a slip, or using a direct debit terminal. (p. 25)

Among other advantages, this would enable planners to profile demand, and generally "keep track" of people who might deviate from the plan.

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these calculations could be performed with such frequency as to assure that the "dynamic" character of demand is adequately taken into account. Determining the quantity and distribution of higher order goods to be produced turns out to involve a macroscopic version of how a good is valued in labor time in the first place, the good replaced by gross demand in a given industry.

C&C summarize what they think they have accomplished:

> We have outlined a mechanism which is capable of adjusting the pattern of output of consumer goods in conformity with a changing pattern of demand. While this mechanism relies on a market of sorts, it is quite distinct from the capitalist mechanism–it depends neither on private property in the means of production, nor on the formation of market prices for the inputs to the production process. (1993a or c, p. 109)

Not only must the planning process be "booted," so to speak, by "a market of sorts," but the market (or a market) seems to determine what counts as the expenditure of labor time, that is to say what counts as an economic object in the first instance (C&C 1993c, p. 19; Nozick 1974, pp. 259-60). Such an object whether it is produced in a capitalist or socialist economy must after all, as Marx puts it, represent a use value, such usefulness can only be determined by there being a willingness and ability to exchange something for the object, and such an exchange relationship is a market (1993c, pp. 16-17).

C&C put this in perspective as they recall approvingly Marx's discussion of the slightly different matter of labor certificates:

> in commodity producing society, what is socially necessary emerges only through market competition. Labour is first of all "private" (carried out in independent workshops and enterprises), and it is validated or constituted as social only through commodity exchange. The social necessity of labour has two dimensions. First of all, we are referred to the technical conditions of production and the physical productivity of labour. Inefficient or lazy producers or those using outmoded technology, will fail to realize a market price in line with their actual labour input, but only with the lesser amount which is defined as "necessary" (with respect to either average productivity or best practice technique–Marx is not always consistent on precisely which). Secondly . . . there is a sense in which the social necessity of labour is relative to the prevailing structure of demand. If a certain commodity is overproduced relative to demand, it will fail to realize a price in line with its labour value–even if it is produced with average or better technical efficiency. (p. 19)

So it is in a capitalistic, commodity producing society. Apparently, the market will not (at least not so strongly) define what counts as socially necessary labor time under C&C's brand of socialism in which "labor does become become 'directly social,' in the sense that it is subordinated to a pre-established central plan" and where "the reshuffling of resources in line with changing social needs and priorities does not proceed via response of profit seeking firms to divergences between market prices and long-run equilibrium values" (pp. 10-20).

Whether this distinction amounts to much of a difference depends at least in part on how much the planning authority allows itself to be governed by the "market of sorts" in consumer goods. The authority, responding to "changing needs and priorities," and in part governed by democratically elicited judgments about these will wind up by ruling that some labor (expended say on moon pies and the *National Review*) is not socially necessary after all even in the face of vigorous demand. Conversely, ignoring a certain lack of enthusiasm, the board might invest the labor represented in sensible shoes and Marx's *Complete Works* with a value well beyond what mere

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aggregated preference could justify.[8] So, it is not just consumer demand that decides what counts as socially necessary labor time, but also, lest they be mere automotons, the planners demand as well, and planners outbid consumers, otherwise, where's the plan?

In any case, the consumer market in C&C's scheme would present a somewhat different "profile" of socially necessary labor than the one to which we are accustomed: some goods and services would evaporate; others miraculously appear, and perhaps all would be valued somewhat differently.[9]

To be sure, responsibility for altering the profile would be shared not only between the planning authority and the consumer market, but also with a kind of political market or, as it is more persuasively described, "democratic decision." C&C point out that this would take various forms and would determine the most general allocation of social labor, but more on this later.

Recall that socially necessary labor time was introduced as an "objective" measure of value and as such proclaimed uncapricious and scientific. It turns out instead to be "subjective" thrice over.[10] It is, as we have seen, created in the first instance by consumer demand, modified or overruled by the planning authority in turn guided to

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[8]The amount of discretion planners would enjoy is evident from C&C's discussion of planners possibly failing correctly to anticipate the proportion of savings to expenditure in the plan's consumer market:

> If net saving falls below the forecast, then Token consumption will exceed the pre-determined level of Consumption. In that case the planners may respond in the next period by raising taxation, encouraging more net saving in one way or another, or increasing the allocation of social labour to consumer goods. Or, if the planners reckon that the sub-forecast saving was a temporary "blip," they may choose not to respond. Exactly parallel reasoning applies in the case where saving is above the forecast level. (p. 106)

Democratic, not to say market constraints in light of such statements turn out to be a bit anemic.

[9]The difference is excused by reference to the alleged superiority of "social decision on the shape of an economy" over "the aggregate of private decisions" (C&C 1993, pp. 61-62). On the failure of such considerations to justify central authority see my article (Brewster 2002, pp. 19-34).

Since not only the market, but any democratic determination is based on "the aggregate of private decisions," if the planners make a social decision that (say) there be fewer private cars, they should prevail, incidently augmenting the need for sensible shoes.

[10]Taking "subjective" as C&C seem to in "Information and Economics," pp. 6-8 as essentially personal, or inescapably related to the subject's mind.

They here argue against the subjectivity (thus understood) of information in part on the basis of the supposed elimination in modern economic theory of individual persons as economic actors in favor of such things as firms, the identification of information with its physical bearers in information theory, and the supposed unassailibility of the theories.

Such an approach confuses useful hypotheses for limited objectives with ontological commitment. Furthermore, the objective/subjective distinction is very crude and nothing much is gained by accepting it uncritically. The distinction, in fact, cries out for something

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whatever degree by democratic processes. That socially necessary labor is measured by numbers on a clock face no more makes it "objective" than recording numbers on a ledger page does such service for consumer preference.

C&C's scheme collapses under slight pressure into a perverse capitalist market in which the desires of planners, consumers, and voters would be unequally represented, the first in case of conflict trumping the other two. Planners would thus be inclined to regard their position as a kind of property or capital: aggressively sought, fiercely defended—by the use of which one could expect a return in the form of whatever currency eluded official suppression.

If, as likely, this currency took the form of consumer goods, exploitation would see the planners using their position to assure that they received a disproportionate share at the expense of voters and consumers. The degree of "exploitation by the plan," as we might style it, could no doubt be precisely measured in terms of socially necessary labor time.

Not so easily quantifiable, but no less exploitive would be the disparities in morale following upon the assertion of the plan at the expense of market demand and democratically expressed aspirations. C&C after all suggest that psychic satisfactions could motivate skilled economic performance no worse than huge incomes (1993c, p. 14). Psychic satisfaction thus being of some value it follows that if my getting more is only assured by you getting less then I have exploited you, though there may not be any uniform quantifiable relationship between my gain and your loss.

Thus, C&C's "New Socialism" is not even spared an exploitive class and the potential for class conflict; for it is not to be expected that consumers and voters will forever stand still as they are robbed and demoralized. We might even anticipate a revolution in which the planners are dismissed through the introduction of money and a market in higher-order goods. Their absence, after all, only facilitates "exploitation by the plan." The rallying cry might be: "Down with the planning Class. Consumers have nothing to lose, but their script. They have the chance of fortunes to win."

Randian Exploitation

Perhaps I am too pessimistic. Let us assume that class antagonisms do not arise within C&C's scheme. They insist, after all, that the inequalities which underlie such conflicts are due to conditions they hope to change:

> Those who suffer under the present dispensation do not need to be told how bad things are; they know this already. The important questions are: what are the causes of the present contrast between poverty and wealth, and what can be done about it. Of these, logically the most important question is the first. What really causes inequality in the present society? The most important causes are: (1) Exploitation of those who work. (2) Inheritance of wealth by a minority. (3) Unemployment. (4) Infirmity and old age. (5) The economic subordination of women. (6) Differences in skills and abilities. (1993a, pp. 11-12)

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like a stratified analysis such as that found in Ingarden (1973) which can be read as showing that as applied to novels and the like the supposed opposition between objective and subjective obscures a very intricate layered structure of physical objects and intentional objects in an orchestrated relationship.

For a more sober approach to information theory see Guttenplan (1994, p. 191).

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The most important of these, as it is merely specified by most of the others, is "exploitation of those who work," and according to C&C, "A worker is exploited if the wages she gets are worth less than the product of the work that she does," the exploiter benefiting to the amount of the difference (p. 12).

Of course C&C hold that the most direct way to measure such exploitation is in units of socially necessary labor time, avoiding the use of "meaningless" pounds, dollars, or euros which only obscure the theft (C&C 1993c, p. 17).[11] But, as we have seen, socially necessary labor time cannot measure value independently of the market. Recall that nothing counts as socially necessary labor time unless so determined by at least a "market of sorts," and whether "socially necessary" is meant as "average" or "state of the art," again we have implicit market determination.

Even if we assume that the sort of market into which we have followed "the New Socialism's" collapse has not developed analogues of capitalist exploitation, we shall only discover what might for obvious reasons be called Randian exploitation.[12] The planners under such a dispensation would work hard, and we shall suppose successfully, to maintain substantial equality. They will be aided in this by the demos, who might, for instance, vote to tax away the inequalities into which the new socialism might otherwise drift.

Suppose the efforts of the planners and the watchfulness of the public assure that A and B both earn 1,000 units a week of whatever one fancies as currency. Suppose, further, that such diligence and concern lapses, and A now receives on an undisturbed market 500 units and B, 1,500. Was A exploiting B, or is B exploiting A? Take your choice. If your baseline is equality, then, of course, B is now despoiling A. If your standard is the unfettered market, then B has happily escaped A's exploitation.

But if there is exploitation, there is inequality of a sort, and even analogues of property come back to haunt us. What makes possible Randian exploitation (say proletarian status) insofar as it does make it possible already functions as capital and so

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[11]The indispenisibility of money on the other hand is argued in Horwitz (1995).

Horwitz, following Hayek, takes the impossibility of socialist planning to be epistemic. I think it is also logical.

For Horwitz money is indispensible as a sort of language by which entrepreneurs, investors, and businessmen are apprised of dispersed tacit knowledge, which cannot, C&C notwithstanding, be furnished by think tanks supported by innovation budgets. Money, as opposed to labor certificates or the equivalent, is incompatible with socialism. So, socialist calculation even with computers sufficient to solve the equations, cannot allow the equations to be set up.

I do not think this is incompatible with the main argument in this paper, but it does rest upon two concepts I find obscure: tacit knowledge and the already mentioned subjective/objective distinction. Furthermore, I find no particular reason to agree with Horwitz and Hayek that "the capacity of any explaining agent must be limited to objects with a structure possessing a degree of complexity lower than its own" (p. 18). It appears to be the function of scientific laws and algorithms to do something like this. But in any case isn't the effect of hand calculators not to say super parallel computers to augment indefinitely our cognitive complexity, even in the near literal sense of adding to our neural structure?

All of these issues demand something like close Ingardian scrutiny.

[12]Perhaps the most vivid novelistic account is Rand's *Atlas Shrugged* (1957).

Agreeing with her that vigorous and intelligent entrepreneurs may be exploited does not commit us to placing them in something resembling the Pantheon.

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will be sought after and defended (bought, sold, exchanged)? The principle instrument of such exploitation will be (and is), of course, democracy.[13]

The value of any contribution to the economy is not something to be "viewed from the standpoint of eternity." You cannot determine in principle who is exploiting whom and to what extent apart from units of measurement tailored to a predetermined result. Choose units of labor with a bias toward physical labor, and it turns out the proletariat is swindled on the free market. Take money earned on an undisturbed market as standard, and those with a knack for entrepreneurship are the victims.

If it is between the anarchy of the market and the arbitrariness of constantly policed equality, then I vote the market, but perhaps all that need be noticed at this point is that equality is at least no less exploitive, and in the worst sense capitalistic, than inequality; so why bother? If the drift to inequality is away from one sort of exploitation to another, why not drift? If it is such a wash, why waste ink on "exploitation" at all?

The Impossibility of Socialist Calculation

Recall that the New Socialism to notice demand had to resort to a consumer market "of sorts." Remember that the moments of socially necessary labor time with which the planners in the socialist commonwealth supposedly do their sums are social, necessary and even labor as determined on a market. Notice that the tatonnements by which the planners adjust to a clearing price on the consumer market amounts to market simulation. And finally, reflect on the defective market, commonly euphemized as "democracy," by which large scale allocations of goods and services in C&C's scheme would be determined. What we have here is obviously a market system "of sorts."

Furthermore, suppose the planners to have any real discretion, and property, inequality, and exploitation rush back upon us, and we do not avoid the same result even on the heroic assumption that equality can be maintained. We not only have a market system of a kind, we have in the worst sense an awkward capitalism.

So, an examination of C&C's New Socialism confirms Mises's conclusion that rational socialist planning is impossible. It appears that in order for economic planners to have any useful data by which they might be guided, a market must be hauled in, and with it analogues of private property, inequality and exploitation. Why?

As I indicated, the trouble is not scale and complexity. Nor is the difficulty just epistmological, though this enters in. The problem is that in order for any rational socialist plan to be formulated, it must utilize markets, but insofar as markets are useful for planning, they must be unaffected by the plan. However, if there is a plan, the markets cannot be unaffected by it. To put it briefly, socialism with markets is a plan that is not a plan. And even an omniscient God could not pull that off.

To be sure, I have not demonstrated this, and it may be that nothing of the sort is demonstrable. My point is that if it is true, that socialist planning does not work,

[13]Obviously because the mediocre and envious will outvote the able and self-confident, and so the former will democratically relieve the latter of their property and innovations. For an enlightening discussion of the subject see (Hoppe 2001).

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it is necessarily true, and if false, necessarily so on the assumptions that such planning must be substantially independent of a capitalist market and must have socially necessary labor time as a measure of value. And neither assumption is in dispute.

The position is similar to that of Goldbach's conjecture, which also if true or false is necessarily so. No one has yet demonstrated it to be one or the other. However, it is widely suspected to be true, and has been repeatedly confirmed.[14]

Socialist planning is similarly suspect, and its failure has been once again confirmed.

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[14]Christian Goldbach's conjecture is that every even number is the sum of two primes. See Kline (1967, p. 46).

Like the conjecture, the impossibility of rational socialist calculation is best seen as a necessary *A Posteriori* truth (or falsehood). It is in other words true (or false) in all possible worlds, but the proof either way must be discovered, if there is such a proof at all. See Kripke (1980, pp. 35-38).

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THE FREE-MARKET INNOVATION MACHINE: ANALYZING THE GROWTH MIRACLE OF CAPITALISM. BY WILLIAM J. BAUMOL. PRINCETON, N.J.: PRINCETON UNIVERSITY PRESS, 2002.

The fundamental idea behind this book, as its title suggests, is that innovation is the driving force behind the remarkable growth miracle of capitalism. Yet, Baumol notes, innovation is at best a peripheral part of the standard theory of the firm and has received only slightly more attention in modern growth theory. In the neoclassical theory of the firm, firms compete based on price, but Baumol argues that in a capitalist economy innovation rather than price is the primary competitive dimension, and less innovative firms will find their markets shrinking as they lose business to their more innovative competitors. Thus, innovation is essential to the survival of firms in a capitalist economy. Baumol argues that innovation belongs at the core of microeconomics, not on its periphery, and he develops some ideas to show how innovation can be incorporated into the neoclassical framework. The book is divided into three parts. Part One lays out Baumol's model of the capitalist growth mechanism. Part Two discusses how his model can be incorporated into the standard microeconomic framework. Part Three looks at the macroeconomic implications of his theory.

Many of the basic ideas in this book are based on Schumpeter's work, and Baumol cites Schumpeter frequently. Baumol also draws on his first-hand experience in consulting work, and discussions with corporate decision-makers, for insights on the way that firms actually do behave in a competitive environment. The result is a theory of economic growth substantially more insightful than the reigning neoclassical growth theory. Still, Baumol is quite reluctant to find fault with contemporary growth theory. He praises the work of Romer, Lucas, and others, but says that he is interested in different questions. Perhaps Baumol is too much of a gentleman to be critical of his fellow economists. It appears to me that Baumol is trying to answer the same questions, and has shown that the neoclassical growth theorists are looking in the wrong places for answers.

Austrian economists will find much to like in Baumol's book, but this is not an Austrian work. Israel Kirzner is mentioned only once in the book, in a footnote, and none of Kirzner's work is cited. Austrians will be sympathetic with the issues and insights that Baumol lays as a foundation, but ultimately Baumol's analysis heads in a neoclassical direction, which results in his theory's bogging down in the same areas as neoclassical growth theory. Even so, this book has much to offer the readers of this journal.

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Part One of the book, where Baumol lays out his theory, is the most insightful. Baumol describes a process in which firms compete with each other based on innovation rather than price. He notes that successful firms can be inefficient in the static neoclassical sense and still remain profitable if they continue to innovate, but without innovation, even the most efficient firm (in the static sense) will be forced from the market by its innovating competitors. This analysis seems right on the mark.

Innovation takes place within monopolistically competitive markets where firms are aware of the activities and innovations of their rivals, and are forced by competitive pressures to respond to them. Because innovation is essential to firms' survival, they cannot leave the process to chance, so they routinize innovation, making it a part of their ongoing business activities. In Baumol's view, R&D is run by managers, not entrepreneurs. "This is not the realm of the unexpected, of the unrestricted exercise of imagination and boldness that is the essence of entrepreneurship. It is, rather, the domain of memorandums, rigid cost controls, and standardized procedures, which are the hallmark of trained management" (p. 36). "Thus, corporate R&D has taken over a substantial portion of the field and has transformed it into a bureaucratized activity" (p. 34).

At this point, Baumol's model takes a very neoclassical turn, and innovation is something that is produced, much like other inputs into the production process. The uncertainties of entrepreneurship are displaced by bureaucratized R&D that can be expected to produce innovations on a regular basis. This raises two issues. First, Baumol goes to great lengths to emphasize the Schumpeterian distinction between invention and innovation. Throughout history, many inventions that could have been put to productive use were not, because there was no incentive to do so. Baumol believes that the market mechanism provides sufficient incentive for corporate bureaucracies to turn inventions into profit-making innovations, but I am skeptical and see a much bigger role for entrepreneurial action in corporate innovation. I will go along with Baumol as far as to agree that R&D expenditures create an environment within which entrepreneurial discovery is more likely, but stop short of believing that in modern capitalism bureaucratized R&D activities have displaced entrepreneurship.

This leads to the second issue. Baumol claims that most improvements in economic welfare are due not to major breakthroughs, but rather to routine improvements in existing products and processes. Independent inventors may provide the initial innovation, but that is only the beginning, and often a small part of the total story. Goods such as automobiles, televisions, and computers were not very useful when they were first invented, but subsequent refinement through R&D led them to be better, cheaper, and more useful, and those subsequent refinements are what have produced really large improvements in welfare. For example, Baumol claims that 99 percent of today's computing power is due to incremental improvements in the technology rather than major breakthroughs. Baumol's free-market innovation machine routinizes the process that produces 99 percent of that innovation. Without questioning Baumol's 99 percent figure, I still am not convinced that the real engine of innovation is the corporate R&D that has produced 99 percent of today's computing power rather than the entrepreneurial insight that led to that first one percent. Put differently, is the engine of the innovation machine the original insight that produced the innovation, or is it the incremental improvements that have made the innovation significantly more useful and affordable? I would answer the former, although Baumol answers the latter. Still, Baumol recognizes the importance of entrepreneurship,

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saying, "In this process there is no reason to expect independent inventors or innovators to become obsolete any time in the foreseeable future" (p. 57).

Because innovation is essential to a firm's survival, routinization of innovation is an integral part of business. Firms must devote sufficient expenditures to match their rivals' innovation, which leads to what Baumol characterizes as an arms race in R&D expenditures. Such an arms race could lead to a substantial amount of wasted resources if the competitors used their R&D in duplicative ways, or in ways to try to shut each other out of the market, but Baumol persuasively argues that this is not characteristic of the R&D arms race. Firms cannot afford to be put in a position of being leapfrogged by a rival's superior innovation, so firms have an incentive to share their innovations in a number of ways. Baumol devotes two chapters to the sharing of technological advances among firms. He convincingly argues that firms have an incentive to share their technological advances through arrangements such as licensing, exchange agreements, and the joining of technology exchange consortiums.

Firms that engage in such exchange give themselves competitive advantages over firms that attempt to go it alone, as Baumol demonstrates both formally and with a wealth of examples. Many firms then have access to the best technology, but have an incentive to innovate to collect royalties from licensing, and to have valuable technology to trade with other firms. Baumol's discussion of the way in which the results of innovations are distributed among competing firms through market mechanisms presents a persuasive argument that innovation-sharing in the modern market economy leads to efficient economic outcomes.

In Baumol's model, the capitalist economy grows because oligopolistic industries use innovation as their primary competitive weapon, and the routinization of innovation turns it into a reasonably predictable business activity rather than a series of fortuitous events. Incentives within the marketplace force firms to continue the innovation that has produced the growth miracle of capitalism.

In Part Two of the book, Baumol wants to take his ideas and integrate them into the standard theory of the firm. This is a worthwhile endeavor, but conceptually there are problems with the way he has proceeded. By trying to shoehorn a theory of innovation into a theory that is based on prices and quantities, the true nature of innovation seems to have been left behind in Part One. Innovation can shift out the demand curve by making products more desirable, or shift out the supply curve by making them cheaper to produce, but when it is characterized this way, innovation never results in the new products that have so transformed the world. Perhaps this is just how Baumol sees it, because as already noted, Baumol places much more emphasis on the incremental improvements to innovations than to the original innovations themselves.

Baumol argues that innovation is essential to understanding oligopolistic competition. With heavy up-front R&D costs that are necessary for firms to survive, price discrimination is necessary for firms to stay in business. Baumol's argument is plausible, and he tries to put this into the standard neoclassical framework, but the argument reads more like one that was invented to defend the actions of a price-discriminating firm than one intended to advance the state of economic theory. Nevertheless, the plausibility of the argument suggests that Baumol's observations through his consulting work and other first-hand experience can lead to an economic theory more in tune with the realities of the real-world economy.

Ultimately, Part Two of the book is less inspiring than Part One because the discussion of innovation, improvements in product characteristics, and the introduction

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of new products, all end up being depicted as shifts of supply and demand curves and not only are the issues about the origins of innovations glossed over, the innovations themselves seem to be left behind, depicted only as changes in costs and demands in the market under analysis.

Part Three of the book, titled "On the Macrodynamics of Capitalism," is the shortest of the three parts, but offers the reader some interesting ideas. Modern capitalism is only a few centuries old, and Baumol wonders whether the free-market innovation machine might slow down and ultimately stop growing. Baumol argues in Chapter 15 that R&D is relatively labor-intensive, so over time its cost can rise relative to the rest of the economy. As the relative cost of R&D rises, firms may do less of it, resulting in slower growth. Thus, Baumol develops a theory for an endogenous end to the industrial revolution, noting, "the explanation for this rise and fall of entrepreneurial activity is grounded in simple dollars and cents—in the changes in the economy's structure of payoffs" (p. 60). This is an interesting speculation, but one wonders, in the computer age, with expensive R&D facilities, whether R&D really is labor intensive. Baumol goes on in Chapter 16 to argue that innovation facilitates more innovation, so growth may not slow after all. On balance, Baumol is optimistic that the free-market innovation machine will continue to produce economic progress, despite his theory about why it might not.

Baumol notes the importance of market institutions and the protection of property rights to provide incentives to innovate, and while he does not suggest that government regulation of business activity be done away with, he does say that regulations must account for the dynamic characteristics of innovative industries rather than being based on neoclassical principles of static efficiency. Baumol notes that entrepreneurial actions can be directed toward profit-making activities, or rent-seeking, so it is important to limit rent-seeking opportunities, but he does not go on to examine the incentives facing regulators to see whether they benefit more from rent-seeking entrepreneurs rather than profit-making entrepreneurs. Baumol recognizes that in some places, such as medieval China, incentives were such that entrepreneurial actions were directed toward rent-seeking activities, so this suggests that to follow through on Baumol's ideas on regulation, more analysis of the political incentives in contemporary capitalism needs to be undertaken. Baumol's discussion of the importance of the institutions of capitalism is surely correct, but is, at best, peripherally related to the main thrust of his argument.

Readers of this journal will surely appreciate Baumol's attack on Pareto optimality as the benchmark for the efficient allocation of resources. Baumol notes that innovation results in many information spillovers, and that following the standard criteria for efficiency, spillovers result in inefficiencies. Yet these spillovers allow the benefits of innovation to be spread beyond the innovators, making everybody better off, and on distributional grounds, Baumol argues that the fact that ultimately everyone benefits is a good thing. If spillovers were completely prevented, innovators would capture all of the benefits of their innovations, leaving most people in the same conditions of poverty that existed at the beginning of the Industrial Revolution. If the distributional benefits are unquestionably desirable, then the spillovers that have allowed them must be desirable too, calling into question the neoclassical criteria for optimality in the allocation of resources.

This book is at its strongest when, mainly in Part One, Baumol shows the weaknesses in standard growth theory and argues that innovation needs to play a central role. It is weaker when Baumol tries to place his insights in a neoclassical framework,

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because the insights he argues should be in the model seem to disappear from it at this point. Part of the issue here may be which element of the free-market innovation machine is really responsible for the remarkable economic progress of the past three centuries, and for future economic progress. I do not take issue with Baumol's observation that most of the utility in technological products comes from more routine innovation that takes place after the product has entered the marketplace. Refinements and advances in many products have made them much more useful and affordable now than when they were introduced by their original innovators. And, I would agree that much of this innovation has been routinized through the R&D activities of modern businesses. Yet I believe that Baumol underestimates the entrepreneurial element in bringing the results of R&D to market, and underestimates the importance of the process that first creates the innovation. Baumol wants to describe the free-market innovation machine, but is there any reason why this routinized and bureaucratized R&D could not be undertaken by research labs in a centrally-planned economy?

The fact that refinement has been routinized seems to support the argument that continued progress requires a cultivation of that spark of entrepreneurship that starts the process in motion, and that the spark of entrepreneurship rather than the bureaucratized process of refinement is the real miracle of the free-market innovation machine. The R&D that Baumol emphasizes has become just another part of the manufacturing process, and Baumol deliberately presents it that way, but perhaps the entrepreneurial acts that have not become routinized are those that really separate the miracle of capitalist growth from other types of economic organization. The R&D that took place in the former Soviet Union could be described in the same terms Baumol uses to describe the bureaucratized corporate R&D of a market economy.

One way to look at this issue is to contrast Kirzner's depiction of entrepreneurship with Baumol's innovative process. Kirzner sees entrepreneurship as the recognition of a previously-unnoticed profit opportunity, which is costless and uses no resources. Baumol's depiction of the routinization of innovation through bureaucratized R&D removes that Kirznerian element from innovation, and is costly to undertake. Baumol does recognize the role of Kirznerian entrepreneurship (or something like it) in introducing innovations into the market, but suggests that this is a small part of the free-market innovation machine, and the more he formalizes his ideas, the less that Kirznerian element appears in it. While one might question Baumol for marginalizing the role of entrepreneurial insight, one might be equally critical of Kirzner for minimizing the innovative nature of entrepreneurship to focus on its equilibrating nature. Indeed, Kirzner's criticism of Schumpeter contrasts with Baumol's embrace of Schumpeter's ideas. The point is that without giving up any of Kirzner's ideas, Baumol still has much to offer his readers.

My biggest reservation about Baumol's book is that I think he points readers in the wrong direction by emphasizing the importance of routinized R&D as the engine of economic progress over entrepreneurial insights. I am skeptical that corporate planning and bureaucratized R&D really is the engine of economic growth, despite its undeniable contribution to continual improvements in the standard of living. Baumol's discussion of routinized R&D also leaves some unanswered questions. In this routine R&D that is necessary for firms to survive, where do the good ideas come from, and how do firms identify marketable ideas? Once they do, how do those good ideas get into the marketplace? The apparently small step between R&D and a marketable product is where entrepreneurship enters the picture. Baumol makes reference to ancient China, for example, to show how remarkable inventions do not necessarily

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result in innovations that improve the standard of living. In what way are his bureaucratized corporate R&D activities different from inventive ideas in ancient China? Yes, the R&D Baumol describes takes place in a market environment, giving firms an incentive to market their innovations, but Baumol does not delve into how market institutions facilitate firms' ability to respond to this incentive.

Consider Xerox's development of the graphical user interface and computer mouse, which did not result in a marketable product for them, but transformed the product lines of Apple Computer and Microsoft. Consider Apple's failed handheld computer, the Newton, followed by the successful introduction of the Palm Pilot. These examples suggest that the path that leads from R&D to marketable products often is not routine, and that Kirznerian entrepreneurial insight remains a big part of the free-market innovation machine.

Despite my reservations on some points, Baumol has much to offer to economists generally, and specifically to those committed to Austrian theories of entrepreneurship and growth. His analysis of the shortcomings of current theories of growth are on target, and coming from a well-respected mainstream economist may have an influence on mainstream growth theory. Baumol's ideas on how the theory of the firm should be modified to take into account innovation are especially insightful. His attempt to integrate these ideas into the standard theory of the firm is worthwhile, even if not completely successful, and his integration of real-world institutions–especially with regard to technology transfers among firms–connects his theories with real-world institutions in a way that more economists should emulate. This book is an ambitious undertaking, and Baumol has largely succeeded. Baumol's ideas depart significantly from the Austrian tradition, but Austrian economists will benefit from reading this book.

RANDALL G. HOLCOMBE
Florida State University

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Complexity, Risk, and Financial Markets. By Edgar E. Peters. New York: John Wiley and Sons, 1999.

Complexity, Risk, and Financial Markets completes a trilogy of books on chaos and fractal analysis. Fractal analysis examines self-similarity or scale invariance, a structure that is often present in seemingly random and otherwise complex processes. Time series, for example, exhibit self-similarity if subsamples resemble compressed versions of longer samples. Pioneered by engineers, mathematicians, and natural scientists, fractal analysis is now routinely applied to financial markets. Author Edgar E. Peters is a leading practitioner and also chief investment officer at PanAgora Asset Management, a distinguished quant firm managing over $13 billion. Peters published *Chaos and Order in the Capital Markets* in 1991 (expanded and corrected second edition 1996), a conceptual application of fractals and chaos theory in economics and finance, followed by the more technical *Fractal Market Analysis* in 1994, which remains an excellent introduction to fractal methodology, though recent advances have rendered it technically obsolete in some respects. *Chaos and Order in the Capital Markets* includes a sophisticated and devastating critique of the efficient market hypothesis.

Complexity, Risk, and Financial Markets completes Peters's trilogy by presenting the underlying philosophical case for chaos theory, which turns out to be grounded on distinctively Austrian views of information and market process. This book should be read by Austrians interested in, or already familiar with, fractal analysis or chaos theory, a statistical methodology developed extensively by Benoit Mandelbrot.[1] In addition, this book should also be read by practitioners of fractal analysis and related statistical techniques, in order to receive an introduction to the Austrian School and deepen their understanding of their methodological paradigm's justification, implications, and limitations.

Although it can be read profitably on its own, *Complexity, Risk, and Financial Markets* calls for some discussion of the context it occupies in the larger trilogy. In particular, this book serves as a philosophical background and introduction to Peters's two earlier books, to which readers should go for more detailed critiques of

[1]See particularly Mandelbrot (1963a, 1963b, 1972); Mandelbrot and van Ness (1968); and Mandelbrot and Wallis (1969) for the original applications to income distributions and the distribution of financial returns. Fractal analysis of asset returns is of special interest because it can provide conclusions about the market processes which generate asset prices.

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market efficiency and conventional quantitative economics, as well as a range of empirical applications of fractal analysis. Peters's applications use financial or macroeconomic data, and give readers a good feel for how these statistical methods can be used in research. Though many applications are common to both earlier books, some of the techniques described in *Fractal Market Analysis* have been superseded. Anyone interested in conducting a fractal research program should refer in addition to more advanced techniques.[2] In addition, fractal analysis can be applied in many situations where conventional econometrics and statistical inference are invalid. *Chaos and Order in the Capital Markets* and *Fractal Market Analysis* remain outstanding guides to interpreting fractal analysis as applied to finance, and constitute the best introduction to the literature.

Complexity, Risk, and Financial Markets is an engaging book, abounding in the kind of memorable and succinct examples that can inject more life and relevance into anybody's classroom teaching. Simultaneously, it offers a broad, philosophical look at how market economies self-organize into complex and sometimes chaotic systems. Peters introduces uncertainty as a necessary precondition for the market order, which arises spontaneously through the interaction of self-interested individuals. Very specific conditions are required for such an order to be stable, and Peters notes economic markets are unstable in societies like Sudan and Bosnia, where uncertainty may be high but where little complexity is present (p. 191).

Central planning aims at removing this uncertainty, but makes it impossible for markets to function. Planned economies attempt to insulate their citizens from risk, but can succeed only to a limited extent. A free market operates beyond the control of any one individual. Investment in a planned economy should offer a guaranteed return, but clearly things do not always go according to plan. Often, planned economies suffer greater impact from uncertainty precisely because they lack the flexibility and freedom of a market economy. Peters notes that uncertainty goes along with freedom of choice, forming a necessary precondition for competition and innovation, two things a planned economy attempts to do without.

Although he sees many problems with government intervention, he is frequently critical of monopoly pricing (contrast particularly with Mises 1998, pp. 357-62), and concludes government regulation is the best hope for solutions to market failure and the business cycle. Deterministic markets, the ideal of central planning, cannot survive, as the first person to solve the riddle of deterministically chaotic market structure would eventually accumulate all wealth. In addition, however, Peters feels markets must be regulated to ensure competition and equal access. Peters criticizes the Austrian School for its rejection of antitrust regulation (pp. 181-83), and develops a rationale for the Microsoft antitrust case (p. 113). He makes the argument that antitrust regulation is necessary to ensure competitive markets. In his view, spontaneously evolved market order may be suboptimal, and then must be improved by government intervention.

Peters's critique of the Austrian positions on antitrust, though well-reasoned and thought-provoking, would likely be better received if he made more explicit what

[2]See particularly those described by Calvet, Fisher, and Mandelbrot (1997), Cheung (1993), Lo (1991), and Mandelbrot, Fisher, and Calvet (1997).

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kinds of intervention he felt could be justified. Like all complex systems, free markets must be stable but must also be free to grow and adapt. The structure must be decentralized to be capable of incorporating many individuals' subjective goals. Free markets need rules that do not constrain uncertainty, but also encourage cooperation and trust, promote coordination, protect property rights, and ensure competition. Implicitly, Peters seems to require very strict limitations on the kinds of market regulations he would accept, and it is a weakness of his argument that these limitations are not made more explicit. It is not entirely clear that Peters's position on antitrust regulation is really different from Mises's.

Self-organizing systems like the market order, patterns which emerge spontaneously from the actions of independent and (externally) uncoordinated individuals, result when individuals respond to one another, a broad class of behavioral responses conventionally categorized as feedback. Adam Smith recognized this principle when he described the coordination of productive activity in a free market as the working of an invisible hand.

Peters contrasts the approaches to uncertainty taken by mainstream or Keynesian economics and subjectivist or Austrian economics. Mainstream economics assumes uncertainty can always be modeled mathematically, and that everyone should arrive at the same assessment of an uncertain event's probability, at least given the same information. The Austrian School notes every individual always perceives a unique information set, and that each individual values every item of information in a unique manner. Even if participants had identical information, their assessment of its importance would be subjective. One person's behavior may be quite different from another's, even facing identical choices.

Peters invokes the Austrian theory of subjectivism to criticize mainstream theoreticians' frequent recourse to representative agents. Peters motivates his presentation by providing examples of how market participants attempt to project a spurious order on their understanding of the world (pp. 11-14). Chaotic behavior, which can display seemingly nonrandom structure, but is generated by random, uncoordinated influences, can thus inspire conspiracy theories, convenient assumptions which explain observed regularities.

Peters praises the Austrian School for its recognition of the diversity and uniqueness of market participants, supporting a more realistic economics. Investors, for example, are not all alike–each has a unique and subjective combination of time horizon and risk tolerance. In contrast, mainstream and Keynesian economics ignore differences among individual agents by assuming, for simplicity and analytical convenience, that everyone is identical, or that differences among market participants do not matter and can be ignored. The diversity of individual goals and actions enables entrepreneurs to create profit opportunities by better satisfying individual wants. The Austrian School views knowledge as subjective, and unique to the individual who acts on that knowledge. Far from consisting of identical agents, the real economy consists of perfectly unique agents who react differently in response to the same information.

A market process is a complex process because it works toward individuals' goals of moving goods and services to those who value them the most, and because the market works for its own survival. The market is not a living being, but in some ways acts as if it were. In Peters's view, mathematics has finally caught up with the Austrian School's intuitive models (p. 63), and he believes that quantitative, though possibly nondeterministic, models will emerge based on Austrian insights.

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Though developed extensively in *Chaos and Order in the Capital Markets*, Peters extends his critique of the efficient market hypothesis, which he views as being fallaciously based on homogeneous expectations and valuation. In the Austrian view, these are subjective factors, and thus heterogeneous. It would be impossible for one price to reflect everyone's information even if everyone has the same information, because our evaluation of the facts is subjective and unique (p. 91). Peters emphasizes differences in investment horizons as the principal source of heterogeneity in the investment market, rather than differences in risk tolerance. He suggests the stability of financial markets is directly proportional to the diversity of participants' knowledge bases and investment horizons. When long-term investment funds dry up, short-term assets experience bubbles, and volatility increases. When no particular criterion dominates the market, valuation is less likely to be distorted, and volatility declines.

Peters suggests the business cycle results from the complexity necessary for financial markets to provide liquidity without systematically favoring one investor over another. His treatment of business cycles is particularly weak from an Austrian perspective; his discussion owes more to Schumpeter than Hayek or Mises. Peters's view of business cycles is that they are a natural and inevitable part of the market process, rather than externally imposed by credit manipulation. Adoption of the Schumpeterian business cycle seems more due to the author's admiration for Schumpeter's theory of the entrepreneur than conscious rejection of Austrian capital theory.

In financial markets, investors compete to employ capital in the most productive manner, and to provide liquidity to whoever is willing and able to pay the most. The market has no mind of its own, but rewards investors who succeed in this competition, and this steady process of creative destruction drives the business cycle. In Peters's view, the Great Depression and the Asian financial crisis led to market reforms which laid the foundation for future prosperity. It is somewhat disappointing that there is little reference to Mises's and Hayek's theories of the business cycle. Austrian capital theory's emphasis on the discoordination caused by credit inflation as the driver of the business cycle may have been more relevant to Peters's thesis. The Austrian conception of the government and/or the central bank's attempt to manipulate and control investment spending leading to malinvestment seems highly complementary with Peters's critique of central planning.

Complexity, Risk, and Financial Markets presents a coherent overview of how local randomness, existing at the level of diverse and independent individuals, interacts to form the global structure of a market economy, which is stable and yet continuously in flux. It can be read profitably on its own, or as the philosophical introduction to the trilogy it forms in conjunction with Peters's (1994, 1996) two other books on fractal analysis. Although Austrians will occasionally take exception to minor conclusions, Peters's trilogy remains the best introduction to fractal market analysis, and the final volume demonstrates the largely Austrian foundation on which the economic interpretation of fractal analysis is based.

ROBERT F. MULLIGAN
Western Carolina University

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NAKED ECONOMICS: UNDRESSING THE DISMAL SCIENCE. BY CHARLES WHEELAN. NEW YORK: W.W. NORTON, 2002.

For the usual readers of free market books, *Naked Economics* promises exciting reading. Charles Wheelan, an American correspondent of London's *Economist* and a lecturer at Northwestern University, promises to "undress the dismal science." Undressing in this sense means "stripping away all of the diagrams, equations, and jargon" and making it the science of real life. "Dismal" means that misunderstanding of the science that equates it with boredom, vagueness, and sheer dullness that Thomas Carlyle forever smeared economics with. In the Foreword, Burton Malkiel calls the book "truly unique," because Wheelan succeeds in giving us "a delightfully readable guide to economic literacy."

And partially, it's true. *Naked Economics* is a very important defense of the free-market philosophy. At this time, when the markets are, again, accused of performing all kinds of evil deeds, books like this are important. And when explaining all the benefits of the market economy, Wheelan is truly superb. His examples are clear, right on the mark. It is when Wheelan tries to be "objective" and finds fault with the market that he becomes, well, amateurish.

For example, while trying to explain externalities that the "market" produces, he simply states that "[t]here is no market solution in this case; the market is the problem." (The whole sentence is italicized in the book. Wheelan wants us to understand he is not naïve: the market is not a perfect economic system [p. 44].) The "market" pollutes, the "market" creates "social" cost that private actors don't bear, the "market" even forces people—I'm not making it up—not to clean up after their dogs in public parks. As any good amateur, Wheelan offers the obvious solution to externalities—the government.

But, externalities, and the explanations thereof, are what separates economics from, to borrow from Mises, pseudo-economic literature. Here we can see how much somebody understands the market as a social process. The truth is, every human action creates externalities, whatever the economic or political system. Every good economist understands that. Even Wheelan comes close! While his discussion about externalities comes in the beginning of the book, at the end, when he discusses the benefits of international trade, he has this to say: "In the short run, just about any economic activity generates waste. If we produce more, we will pollute more" (p. 204).

OK, so it is "we" who produce the externalities, not the "market." But if this is true, how can a government solve this problem? By forcing us to produce less? Or forcing us to pay higher prices in the name of paying for some alleged "social" cost?

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(Wheelan prefers the latter.) If externalities are (to quote Mises again), "a datum which the actors must take into account," then a proper tort system can possibly establish responsibility for damages inflicted on third parties, but can do nothing to eliminate them.

Wheelan himself agrees that the government is the obstacle to a higher standard of living, and still, when in doubt he runs to the government for help. If the statement that "When government controls some element of the economy, scarce resources are allocated by autocrats or bureaucrats or politicians rather than by the market" (p. 67) is true, then the problem of externalities must be solved by the market participants if we want a better life.

Another example of pseudo-economic reasoning is the treatment of the Federal Reserve system. According to Wheelan, the "big picture" is that the Fed is here "to facilitate a sustainable pace of economic growth." Left to itself, the market can never do that. But with the Board chaired with somebody so wonderful as Alan Greenspan ("aptly," according to Wheelan, called Maestro), we don't have to worry too much. Yes, "It's a hard job," yes, "Monetary policy is tricky business," but a "skilled hand on America's credit tap" beats the alternative of the market chaos that we get if money is a commodity not being able to be manipulated for macroeconomic purposes.

But if Greenspan knows how much money is needed in a huge economy like ours, then he must also know how many pairs of black shoes size 10 we need. If he knows what is the right interest rate for home buyers, car buyers, or furniture buyers, then he must also know how many houses, cars, and sets of furniture we need. And if he knows all that, we don't need the free market in the first place. What we need is an economy planned by Alan Greenspan. But it is Wheelan himself who tells us that "The market economy is a powerful force for making our lives better" (p. 18).

These two examples are not mere quibbles, unfortunately. A lot of free-market economists don't see their inherent contradictions. Either the market works or it does not. If one cannot plan the economy, for all the reasons they give, then the markets must be left alone. But if planning is possible, then the markets being inferior to planning must be abandoned entirely. These economists believe that the solution is—in a third way. The trouble is, as Ludwig von Mises indisputably showed, the third way is impossible. In the end, when the third way collapses, one has to choose: back to the free market or forward to undisguised socialism.

In both cases described above, it is exactly the government that destroys the workings of the market and then the antimarket ideologists accuse the market of failing. And herein lies the main problem with economists like Wheelan. Since in the real life the markets never exist without government interference, how do they decide whom to blame when something goes wrong?

The market is nothing but shorthand for a complex social process in which people exchange less desirable situations for more desirable situations. As such the market cannot fail. *Ex post*, a lot of people may find out that the exchange did not improve their situation, that they made a mistake. Disappointed, then they go and blame the "market." This is the root of all antimarket feelings.

But, the biggest shortcoming of the book, at least for me, is something that most readers may not even notice. For quite some time, I've been wondering how some authors can spend hundreds of pages talking about free markets and never—NEVER—mention any of the numerous Austrian economists, past or present. This book is one

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such example. While Wheelan believes that "[t]here is nothing wrong" with "the central insight of John Maynard Keynes," i.e., that by using fiscal policies, "spending, tax cuts, or both," we can "fine-tune" the economy, while he quotes Paul Krugman as an advocate of a free market several times, one can look in vain for any quotation by Friedrich Hayek who won even a Nobel prize in 1974, or Ludwig von Mises, who refused to be accepted by mainstream economists because of his uncompromising beliefs in the logic of free markets, or Israel Kirzner, or any other less known members of the Austrian School who have published thousands of books and innumerable articles on the same topic. Was he afraid that he wouldn't be taken seriously if some Austrians had been mentioned? Or has he never read any of the books or articles published by the Austrians?

So, what final judgment does the book deserve? Its main message is indisputable: people who trade, whether locally or internationally, live better than those who don't. To be able to trade they have to be free in producing and free in consuming, endowed with certain rights and allowed certain liberties. As I was saying, with some exceptions, all this is good and well. Nevertheless, the book has left a bitter taste in my mouth: the mainstream economics cannot admit defeat. They cannot openly admit that the economics of a free market already exists, and has been defending the logic of the market for the last 100 years.

Wheelan ends with this message: "The sad irony of Econ 101 is that students too often suffer from dull, esoteric lectures while economics is all around them. Economics offers insight into wealth, poverty, gender relations, the environment, discrimination, politics—just to name a few of the things we've touched upon. How could that possibly not be interesting?" (p. 236). So if using math is "dull and esoteric," and if economics is about real life, would it be honest to mention those who said it first?

IVAN PONGRACIC
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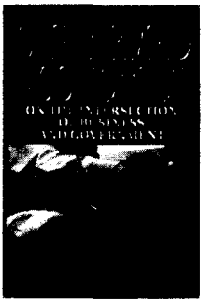

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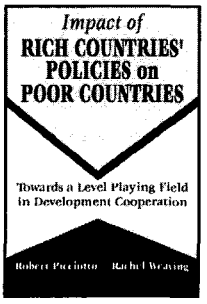
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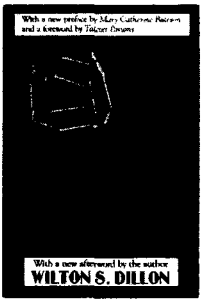

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DIMENSIONS[1] AND ECONOMICS: SOME PROBLEMS

WILLIAM BARNETT II

> . . . the units of all physical quantities, as well as their magnitudes, [should be included] in all of his calculations.[2] This will be done consistently in the numerical examples throughout the book.
>
> –Sears and Zemansky, *University Physics* 1955

The consistent and correct use of dimensions is essential to scientific work involving mathematics. Their very existence creates the potential for errors: omitting them when they should be included, misusing them when they are included, and others. However, their existence also makes possible dimensional analysis, which can be a significant factor in avoiding error. In the equation $y = f(\cdot)$, if y should have dimensions then so also should f, and they should be identical to those of y. If y should not have them then neither should f have them. Such an analysis of $y = f(\cdot)$ would determine: (1) which, if any, dimensions y and each element of f, and consequently f, itself, should have; and, (2) whether the dimensions of f and y are identical, which is a necessary, though not sufficient, condition for the equation to be correct. An error revealed by a correctly performed dimensional analysis indicates a fundamental problem.[3] Therefore, the importance of dimensions for science can hardly be overstated.

The first sections of this paper consider, respectively, the following two problems that arise when dimensions are not correctly included in economic models: (1) those that are meaningless or economically unreasonable; and, (2) those that are inconstant–i.e., the same constant or variable having different dimensions, as if velocity were sometimes measured in meters per second and other times measured in meters only or in meters squared per second.[4] The third section provides a macroeconomic example of the "dimensions problem" from an article in a recent issue of a leading English language economics journal. Section four contains a discussion; and the final section, the conclusions.

The analysis in this paper concerns production functions and is robust with respect to increases in the number of independent variables and to alternative functional forms.[5] Moreover, the analysis is robust with respect to others used in economic theory: e.g., utility, demand, and supply functions.

WILLIAM BARNETT II is associate professor at Loyola University New Orleans. The author wishes to thank an anonymous referee of this journal for incisive and very helpful comments on an earlier draft. The author also wishes to thank his colleague, Walter Block, without whose encouragement and assistance this article would never have seen the light of day.

[1]Throughout, "dimensions" is used generically and "units," specifically. Thus, distance is a dimension and centimeters, meters, and feet are among the alternative units of the distance dimension.

[2]Sears and Zemansky (1955, p. 3) distinguish units and magnitudes, magnitudes being pure numbers, as follows:

> We shall adopt the convention that an algebraic symbol representing a physical quantity, such as F, p, or v, stands for both a *number* and a *unit*. For example, F might represent a force of 10 lb, p a pressure of 15 lb/ft^2, and v a velocity of 15 ft/sec. When we write $x = v_0t + \frac{1}{2} at^2$, if x is in feet then the terms v_0t and $\frac{1}{2} at^2$ must be in feet also. Suppose t is in seconds. Then the units of v_0 must be ft/sec and those of a must be ft/sec^2. (The factor $\frac{1}{2}$ is a *pure number*, without units.)

[3]Sears, Zemansky, and Young state:

> When a problem requires calculations using numbers with units, the numbers should always be written with the correct units, and the units should be carried through the calculation as in the example above. This provides a useful check for calculations. *If at some stage in the calculation you find an equation or expression has inconsistent units, you know you have made an error somewhere.* In this book we will always carry units through all calculations, and we strongly urge you to follow this practice when you solve problems. (1987, p. 7; emphasis added)

> Dimensional analysis is used to check mathematical relations for consistency of their dimensions . . . *[i]f the dimensions are not the same, the relation is incorrect.* (Cutnell & Johnson 2001, p. 6; emphasis added)

[4]These are *not* those of aggregation in disguise; they can, and do, exist in models of but one good and one resource, labor. Rather, the issues dealt with here are even more basic and devastating for mathematical economics and econometrics than is that of aggregation.

[5]Although not directly related to the subject under discussion, it should be noted that there is a fundamental problem with the use of the mathematics of functions in economics. One *sine qua non* of a function is that, for any specific set of values of the independent variables, there must be a *unique* value of the dependent variable.

"Let X and Y be nonempty sets. Let f be a collection of ordered pairs (x, y) with $x \in X$ and $y \in Y$. Then f is a function from X to Y if to every $x \in X$ there is assigned a unique $y \in Y$" (Thomas 1968, p. 13; emphasis added).

Therefore, it is incorrect to express production relationships in any case in which Leibensteinian style X-inefficiency can exist. For an example of such a situation see note 11.

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MEANINGLESS OR ECONOMICALLY UNREASONABLE DIMENSIONS

One widely used function[6] is a 2-input "Cobb-Douglas" (CD) production function. A typical CD function is given by $Q = AK^{\alpha}L^{\beta}$, in which: Q is the output variable; K and L are the capital and labor input variables, respectively; A, may be a constant or a variable; and, α and β are the elasticity of output with respect to capital and with respect to labor, respectively. Consider a 2-input, CD, production function for a specific good, widgets: $Q = AK^{\alpha}L^{\beta}$. If dimensions are used correctly, output, capital, and labor each must have both magnitude *and dimension(s)*, while α and β are pure numbers. Assume, for example,that:[7]

(1) Q is measured in *widgets/elapsed time (wid/yr)*;
(2) K is measured in units of *machine-hours/elapsed time (caphr/yr)*; and,
(3) L is measured in *man-hours/elapsed time (manhr/yr)*.

Then a dimensional analysis of the production function $Q = AK^{\alpha}L^{\beta}$ establishes that A $(= Q/K^{\alpha}L^{\beta})$ is measured in (*widgets/elapsed time*)/([*machine-hours/elapsed time*]$^{\alpha}$ · [*man-hours/elapsed time*]$^{\beta}$); i.e., in $(wid \cdot yr^{(\alpha+\beta-1)})/\ (caphr^{\alpha} \cdot manhr^{\beta})$.

Only positive values of α and of β are acceptable, as nonpositive values for either, or for both, imply negative or zero marginal productivity of the relevant input(s). If $\alpha = \beta = 1$, then the dimensions of K^{α}, L^{β}, and Q–machine-hours per year, man-hours per year, and widgets per year, respectively–are meaningful. But, the dimensions of A are widgets per (machine-hours · man-hours) per year or wid/(caphr · manhr)/yr. For those dimensions to be meaningful, requires, at a minimum, that the product of machine-hours and man-hours is meaningful, a dubious proposition indeed. However, even if the dimensions are meaningful in this case, they are economically unreasonable. For, if $\alpha = \beta = 1$, the marginal products of both K and L are positive constants (the Law of Diminishing Returns is violated) and there are unreasonably large economies of scale–a doubling of both inputs, *ceteris paribus*, would quadruple output.

Alternatively, if it is not true that $\alpha = \beta = 1$, then either α or β, or both, have noninteger values or integer values of two or greater. Noninteger values of α or β, or both, result in such units as, for example, $(\text{man-hours/year})^{0.5}$ or $(\text{man-hours/year})^{1.5}$ for L^{β}, and similarly for K^{α}. But the square roots of man-hours and of years are meaningless concepts, as are the square roots of the cube of man-hours and the cube of years. Also, integer values of two or greater for α or β, or both, result in such units as, for example, $(\text{man-hours/year})^{2}$ or $(\text{man-hours/year})^{3}$ for L^{β}, and similarly for K^{α}. But the squares of man-hours and of years are meaningless concepts, as are the cubes of man-hours and of years, and similarly for machine-hours. (The units of A are even more meaningless, if that is possible.) Therefore, no matter what the values of α and β, the dimensions are either meaningless or economically unreasonable.

If the same 2-input, CD, production function, $Q = AK^{\alpha}L^{\beta}$, is used, but Q is taken to be aggregate output, then the function is an aggregate, or macroeconomic, production function. However, and for the same reasons as in the microeconomic example, a correct use of dimensions here also yields dimensions that are either meaningless or economically unreasonable. Moreover, an additional problem, that of aggregation, arises in the macroeconomic case.

The problem of dimensions that are either meaningless or economically unreasonable cannot be eliminated by using more complex production functions such as the constant elasticity of substitution (CES); if anything, it is exacerbated.

A correct use of dimensions in these examples, then, yields results that are either meaningless or economically unreasonable. However, these problems only become evident when dimensions are correctly included in the model, which is rarely[8] the case with economic modeling.

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[6]This is an understatement. It is probably no exaggeration to claim that the CD is the most widely used mathematical example in all of neoclassical economics.

[7]Because there are no standard systems of dimensions or units in economics, specific, but nonstandard, units are used. It should be noted that, so long as matters are confined to mathematical models, the issue of dimensions/units can simply, though indefensibly, be ignored, this is no longer true when the matter turns to the estimation of econometric models. Then, data must be used. If every variable is measured in monetary terms, the problem of dimensions does not arise. Of course, measuring every variable in monetary terms raises other problems. For example, although some input variables may be, and sometimes are, measured in terms of nonvalue (i.e., "real") units (e.g., of man-hours for labor input), the input of capital goods is invariably measured in value (i.e., monetary) units, and the output is virtually always measured in monetary units. On the one hand, this raises the aggregation problem *re* heterogeneous capital goods; on the other it presents the difficulty of the circularity of the measurement of the value of the capital because of the role of the interest rate in determining the present value of a quantity of capital goods and the role of the quantity of capital goods in determining the interest rate. On these points see Harcourt (1972, pp.1-46).

Moreover, if real units are used, then production functions are consistent with economic theory in that particular quantities of the various inputs combine to produce a specific quantity of the output. However, if monetary units are used such production functions set economic theory on its head, for then particular values of the various inputs combine to produce a specific value of the output. But, economic theory teaches that the value of the inputs is derived from the value of the output. (Thanks to an anonymous referee calling attention to this omission in the prior submission.)

[8]The only cases the author is aware of are a few instances involving Fisher's equation of exchange.

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Inconstant Dimensions

To reiterate, this problem consists in the same constant or variable having different dimensions, as if velocity were sometimes measured in meters per second and other times measured in meters only or in meters squared per second. It can be illustrated by comparing (Newtonian) gravity[9] with production functions. Gravitation is a force. A force *(F)* exerted on a body may be measured as the product of its mass (m) times its acceleration (a);[10] i.e., $F = m \cdot a$. In the meter-kilogram-second (mks) system the units of F are kilograms • meters /(second^2); i.e., kg • m/(sec^2). Sir Isaac Newton's law of universal gravitation, may be stated:

> Every particle of matter in the universe attracts every other particle with a force which is directly proportional to the product of the masses of the particles [m and m'] and inversely proportional to the square of the distances between them [r^2].
>
> $$F \propto mm'/r^2.$$
>
> The proportion above may be converted to an equation on multiplication by a constant G which is called the gravitational constant:
>
> $$F = G \cdot (mm'/r^2).$$ (Sears and Zemansky 1955, p. 79)

Then: $G = F/(mm'/r^2)$. And, logical and physical consistency require that G have the dimensions of $F/(mm'/r^2)$. Using the mks system $F/(mm'/r^2)$ has the units $(m^3)/(kg \cdot sec^2)$; therefore, G must have the units $(m^3)/(kg \cdot sec^2)$.

This result has been invariant for countless measurements of G over the past three centuries: regardless of the magnitude, the dimensions have always been distance^3/mass•(elapsed time)^2; e.g., $m^3/(kg \cdot sec^2)$ in the mks system.

Unfortunately, such is not the case in economics. Compare that result–the constancy of the dimensions–with the results of measurements of a 2-input, CD production function. Such measurements yield estimates for α, β and A. Invariably, alternative estimates of α, β, and A differ. This is not surprising, but it does present a serious problem. Because A has both magnitude and dimensions, different values of α and β imply different dimensions for A, such that, even though the dimensions in which Q, K, and L are measured are constant, the dimensions of A are inconstant. For example, let Q, K, and L be measured in the same units as in the section "Meaningless or Economically Unreasonable Dimensions." Then, if the magnitudes of α and β are measured as 0.5 and 0.5, respectively, then the units of A are $wid/(manhr^{0.5} \cdot caphr^{0.5})$. However, if the magnitudes of α and β are measured as 0.75 and 0.75, respectively, then the units of A are $(wid \cdot yr^{0.5})/(manhr^{0.75} \cdot caphr^{0.75})$.

The problem of inconstant dimensions (or economically unreasonable results) cannot be eliminated by using more complex production functions such as the CES; if anything, it is exacerbated.

A correct use of dimensions in this example, then, yields inconstant dimensions. Inconstant dimensions are, of course, a nonsensical result. However, this problem only becomes evident when dimensions are correctly included in the model, which is rarely the case with economic modeling.

Macroeconomic Example

Consider the following, from a model in a recent issue of a leading English-language economics journal.

1. In the section on households, the "[f]unction H measures the disutility from work, which depends on hours (N) and effort (U)." The arguments in the utility function of the representative household include $\Sigma\beta^t H(N_t, U_t)$; $t = 0 \ldots \infty$, where "$\beta \in [0, 1]$ is the discount factor" and t is the index of the time period.[11]

2. The section on firms posits that,

> [t]here is a continuum of firms distributed equally on the unit interval. Each firm is indexed by $i \in [0, 1]$ and produces a differentiated good with a technology $Yit = ZtLit^{\alpha}$. Li may be interpreted as the quantity of effective labor input used by the firm, which is a function of hours and effort: $Lit = Nit^{\theta}Uit^{1-\theta}$ where $\theta \in [0, 1]$. Z is an aggregate technology index, whose growth rate is assumed to follow an independently and identically distributed (i.i.d.) process $\{\eta_t\}$, with $\eta_t \sim N(0, s_z^2)$. Formally, $Z_t = Z_{t-1} \exp(\eta_t)$.[12]

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[9]Although in this paper the analysis involves Newtonian gravity, the results of the analysis are robust for all applications in the natural sciences.

[10]It is true that a force is a vector quantity; i.e., it has a directional quality, as well as a magnitude (Sears, Zemansky, and Young 1987, p. 10). However, this is irrelevant for this analysis.

[11]Obviously, the time period index, t, was inadvertently omitted from the consumption variable in the representative household's utility function.

[12]Because effective labor, L_{it}, is an argument in the production function of output, Y_{it}, and because effective labor is a function of the level of effort, U_{it}, Leibensteinian style X- inefficiency can exist in this model. On the importance of this, see note 5.

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3. The section on equilibrium maintains that,

> [i]n a symmetric equilibrium all firms will set the same price P_t and choose identical output, hours, and effort levels Y_t, N_t, U_t. Goods market clearing requires . . . $Y_{it} = Y_t$, for all $i \in [0, 1]$, and all t.

Furthermore, the model yields "the following reduced-form equilibrium relationship between output and employment: $Y_t = AZ_tN_t^{\varphi}$."

Among the conclusions that can be drawn from this model, each of which will be considered in turn, are: (1) the number of firms and the number of households is identical, and is equal to infinity; (2) the quantity of each input used by each firm is identical to the quantity of each input provided by each household; and, (3) there are an infinite number of *differentiated* goods, each of which is *identical* to every other good.

First, the continuum of firms necessarily means that there is an infinite number thereof.[13] Assume, *arguendo*, that the (infinite) number of firms is given by n. Then, as each firm uses the same number of hours, N_t, and the same effort level, U_t, as every other firm, the total hours used are nN_t and the total effort level is nU_t. However, because N_t and U_t also are the hours and effort level of the representative household, unless there are exactly n households providing nN_t total hours and nU_t total level of effort, either the firms are using more hours than the households are actually working, or they are using less. The same can be said for the level of effort. Only if the number of households is n are the number of hours used and the level of effort used exactly equal to the number of hours worked and the level of effort provided. Of course, this would necessarily mean that there is an infinite number, n, of households exactly equal to the infinite number, n, of firms.

Second, because there would be one (identical but for the nature of the output) firm per (identical) household, each firm would use exactly the hours and effort level put forth by one of the households, though, conceivably, the hours and level of effort used by a particular firm would not all come from the same household.

Third, because $Y_t = AZ_tN_t^{\varphi}$,[14] and A and Z_t are both dimensionless magnitudes,[15] Y_t must have the same dimensions as N_t^{φ}. The dimension of N_t is hours (hrs); and φ is a positive, dimensionless, constant.[16] Therefore, the dimensions of Y_t are hrs^{φ}. In any case in which $\varphi \neq 1$, the dimension of Y_t, $(\text{hrs})^{\varphi \neq 1}$ is meaningless; e.g., $(\text{hrs})^{0.5}$, $(\text{hrs})^{1.5}$, and $(\text{hrs})^2$ are meaningless dimensions.[17] Alternatively, if $\varphi = 1$, then $Y_t = AZ_tN_t$, and the dimension of Y_t is the same as that of N_t, hrs. However, in that case, because $Y_t = AZ_tN_t$, the output hours are less than, equal to, or greater than, the input hours as AZ_t is less than, equal to, or greater than one (1). But if output is measured in hours, then the output hours cannot be greater than or less than the input hours; rather, the output hours must be equal to the input hours; i.e., $AZ_t \equiv 1$ and $Y_t \equiv N_t$. Therefore, each and every firm uses input of exactly N_t hrs to produce exactly N_t hrs of output; i.e., there is no net production—not one of the infinite number of supposedly profit maximizing firms produces more hours of output than the number of hours it uses as input.

Moreover, because $Y_{it} = Y_t \; \forall \; i$, the dimension of every firm's output is hrs. Therefore, each of the n differentiated goods produced by the n firms consists of homogeneous hours.

Surely, this model is not defensible.

Discussion

The problems caused by the failure to use dimensions consistently and correctly in production functions—dimensions that are either meaningless, unreasonable, or inconstant—are not minor problems, and by no

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[13] "A set forms a continuum if it is infinite and everywhere continuous, as the set of reals or the set of points on a line interval" (Glenn and Littler 1984, p. 37).

[14] It could be argued that, because Y_t is the output of a single firm, $Y_t = AZ_tN_t\varphi$ is not an example of a macroeconomic production function. However, because there are n identical (but for their differentiated goods) firms, the aggregate production function is $nY_t = nAZ_tN_t$. The microeconomic and macroeconomic functions, then are identical up to a linear scaling factor, n. That the firms' goods are differentiated does not prevent us from aggregating them in this model because, as is shown in the text, the differentiated goods are not differentiated at all; rather, they are identical. (If dimensions were being used, n and Y_t would have dimensions; e.g. firms, and widgets per firm in time period t, respectively. In that case, Y_t and nY_t would have different dimensions: widgets in time period T, and widgets per firm in time period t, respectively. However, because each firm's output is identical to every other firms' output, we could still validly aggregate their outputs by multiplying Y_t by n.)

[15] We are given that: $A \equiv [\lambda_n(1-\theta)/\lambda_u\theta]^{\alpha(1-\theta)/(1+\sigma u)}$; $\theta \in (0, 1)$ and is, therefore, dimensionless; and, λ_n, λ_u, σ_n, and σ_u are positive constants. We know that λ_n, λ_u, σ_n, and σ_u are dimensionless from the context in which they first appear: $H(Nt, Ut) = (\lambda_n N_t^{1+\sigma n}/(1+\sigma_n)) + (\lambda_u U_t^{1+\sigma u}/(1+\sigma_u))$. And, we know that α is a positive, dimensionless, constant from the context in which it first appears: $Y_{it} = Z_{it}L_{it}^{\alpha}$. Therefore A must be a positive dimensionless constant. We also know that Z_t must be a positive, dimensionless, variable because, "Z is an aggregate technology index, whose growth rate is assumed to follow an independently and identically distributed (i.i.d.) process $\{\eta_t\}$, with $\eta_t \sim N(o, s_z^2)$. Formally, $Z_t = Z_{t-1}\exp(\eta_t)$."

[16] We are given that: $\varphi = \alpha\theta + \alpha(1-\theta)(1+\sigma_n)/(1+\sigma_u)$. We know that $\theta \in (0, 1)$, σ_n, σ_u, and α are positive, dimensionless, constants. (See note 3.) Therefore, φ must be a positive, dimensionless constant.

[17] It is true that time (t) squared does have a meaning in the world of the natural sciences, such that the dimensions of acceleration are distance/t^2. But that does not in any way help us find meaning for t^2 in the world of the social sciences.

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means are restricted to production functions. Rather, these problems are both critical and ubiquitous—they afflict virtually all mathematical and econometric models of economic activity. And that, unfortunately, is the way modern economics is done (Leoni and Frola 1977; and Mises 1977).

A more or less standard pattern can be discerned in articles in mainstream economics journals. First, the gist of a theory is concisely developed. Second, a more or less complex mathematical model of the theory is elaborated and solved. Third, an econometric model based thereon is constructed, and estimates of the magnitudes of the parameters and of the relevant statistics are provided. Fourth, there is an explanation and discussion of the empirical results. Fifth, conclusions are drawn. Sometimes some of the mathematical manipulations may be relegated to an appendix if they are considered too abstruse for the body of the paper.

This methodology entails generating hypotheses or retrospective predictions, based on the theory, about the magnitudes of the relevant parameters of the model. Then, using the techniques of statistical inference, the estimated signs and magnitudes of the parameters are compared with their expected signs and magnitudes, respectively, to determine if the hypotheses may be falsified or the retrospective predictions rejected as insufficiently accurate.

Unfortunately, the failure to use dimensions consistently and correctly makes it almost impossible to prevent untenable and unreasonable assumptions from entering into the mathematical and econometric models undetected. Such assumptions, of course, render the models so afflicted virtually worthless. They make possible, as we have seen, such indefensible results as differentiated goods that are identical. (Or, to amend slightly a remark of Coase (1988, p. 185), "In my youth it was said that what was too silly to be said may be sung. In modern economics it may be put into [dimensionless] mathematics.") Such clearly untenable results go unchallenged because the dimensionless mathematics obfuscate, rather than illuminate, the analysis and also because some are intimidated by the mathematics.

Certainly, the problems exposed in the examples could have been avoided had dimensions been used consistently and correctly. Whether, then, the author could have developed a tractable model is a different matter. Nevertheless, it is clear, at least to the present author, that anytime the choice is between a dimensionless, tractable, mathematical model or none at all, the latter is by far the better choice.

None of this should be taken to say that the author whose work provided the example did not have valuable insights into the economic activities with which he was concerned—he well may have. However, that must be determined independently of his mathematical model, as it provides no valid support for his argument.

Conclusions

The economics profession has attempted to achieve the degree of success in understanding, explaining, and predicting events in the social world that physicists and engineers have achieved in the natural world by emulating their methods; i.e., using mathematical and statistical analyses to model, understand, and explain, the relevant phenomena. However, in so doing, economists have failed to emulate physicists and engineers in one essential aspect of their work: the consistent and correct use of dimensions. This is an abuse of mathematical/scientific methods. Such abuse invalidates the results of mathematical and statistical methods applied to the development and application of economic theory.

Neither is this problem a thing of the past, nor is it one confined to lesser or fringe venues. Rather, it is a continuing problem and one found in the leading mainstream journals (and textbooks). Because young minds are formed by such materials, future generations of economists are being brought along in a faulty tradition. And, unless and until this changes, and economists consistently and correctly use dimensions in economics, if such is possible, mathematical economics, and its empirical alter ego, econometrics, will continue to be academic games and "rigorous" pseudosciences. However, if for no other reason than the influence of the economics profession on governmental policies, such games and pseudosciences are not without their costs in the real world.

This is not to say that there have not been advances in economic understanding by the neoclassicals, but rather to argue that mathematics is neither a necessary nor a sufficient means to such advances. Whether it even is, or can be, a valid means to such advances is a different issue. What is certain, however, is that mathematics cannot possibly be a valid means unless and until it is used properly. Among other things, that means that dimensions must be used consistently and correctly.

Addendum

There is an ongoing debate in the literature as to whether Austrian School economists should attempt to publish in mainstream journals or rather in nonmainstream journals created specifically for the purpose of providing a venue for explicitly Austrian work. Among the most recent additions to this literature are Rosen (1997); Yeager (1997, 2000); Vedder and Gallaway (2000); Laband and Tollison (2000); Backhouse (2000); Block (2000); and Anderson (2000).

One issue centers about type one errors; i.e., the exclusion of explicitly Austrian work, regardless of quality, from mainstream journals, and, *a fortiori*, top-tier, mainstream journals. As such, it is implicitly assumed that Austrians should aspire to publish in such journals.

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Perhaps of more importance is the issue of whether Austrians should aim to publish in such journals. This raises the spectre of type two errors; i.e., the inclusion in such journals of material that should have been excluded for lack of quality.

Yeager (1997, pp. 159-64; 2000) attacks the concept of the so-called "marketplace for ideas." The marketplace for ideas in economics is taken to constitute the top-tier mainstream journals. Whereas, the exclusion of Austrian work from these journals is taken to mean that Austrian ideas have failed the test of the market, Yeager points out the perversities of such a test, He argues that Austrian economics is not valueless merely because it is uncompetitive in that market and thus, implicitly, Yeager would agree that there should be a venue for good Austrian work that cannot be published therein. However, he does not claim that such journals have no value, and can be interpreted as saying that Austrians should publish in top-tier, mainstream journals when possible and in specifically Austrian venues only as a fallback position. Vedder and Gallaway (2000) also can be reasonably read to arrive at the same conclusion.

Block (2000, p. 55), presumably on the grounds of type two, as well as type one, errors challenges the very legitimacy of the editors of mainstream journals: "One difficulty is that Vedder and Gallaway *unnecessarily concede* to the very editors they accuse of bias against Austrians *a modicum of legitimacy*" (emphasis added). Anderson (2000) makes explicit the argument that these journals commit many and serious type two errors. Whether he would also prefer the strategy of publishing in specifically Austrian journals as a fallback is not clear. However, Block (2000, pp. 55-56) states that in "[i]n [his] view, the leading economic journals are the Austrian ones."

Most of the debate in the literature cited above concerns anti-Austrian bias of the editors and referees of mainstream journals. *In what follows I question the competence of the editors and referees of top-tier, mainstream journals on other grounds and, therefore, the desirability of attempting to publish in them.* Specifically, I challenge the competence in mathematics of these editors and referees and make the case by relating a real life case. The facts, as revealed in the referees' reports (on a paper submitted for consideration for publication), the response thereto, and the co-editor's follow-up correspondence, prove beyond any doubt that the referees and co-editor were incompetent to judge the paper. And this is not a case of opinion, theirs versus mine; no, it is a clear and indubitable case of their commission of mathematical errors.

One requirement for the proper use of mathematics is the correct use of dimensions/units.[18] For example, dimensional analysis is used in physics and engineering to insure the consistency of the relationships in an equation. The economic variables one sees in the mathematical and statistical models ubiquitous in economics (Backhouse 2000) always involve dimensions. However, dimensions/units are rarely used in economics, and dimensional analysis virtually never. Consequently, I submitted a paper,[19] on this subject to a leading English language economics journal. The paper was an indirect attack on the use of mathematics in economic theory. It maintained that if one uses mathematics in economics one must do so correctly.[20] It demonstrated that a dimensional analysis of production functions, specifically, the Cobb-Douglas, yields meaningless or economically unreasonable, and inconstant, dimensions. It then provided two examples of the consequences of the failure to use dimensions and dimensional analysis in economics, one microeconomic and one macroeconomic, criticizing articles in then-very-recent issues of that same journal. Application of dimensional analysis resulted in the conclusion that both models were untenable and nonsensical.[21]

The paper was rejected. Included with the letter of rejection were the reports of three referees. The following are excerpts from these reports along with brief proofs of the errors therein.

> From referee #1's report:
>
> A "defect" in economic analysis is proposed, in that equations do not properly account for units, and that two sides of equations used generally in economics are therefore inconsistent. It is claimed that this defect is not present in the physical sciences, such as physics, and that this defect invalidates most formal economic modeling. The "defect" is best illustrated by an example taken from the paper, which I shall detail next. I shall then show that this "defect" is also present in physics by using illustrations from a random book off of my shelf that has some examples of simple physical systems. Then I shall argue that this is, in fact, not a defect at all.
>
> From referee #2's report:
>
> Dimensional analysis can only be applied to *laws*.

[18]This is not a difficult thing, and, in fact, there is published work on the subject of dimensional analysis. For an example, see the appendix in Reddick and Miller (1955).

[19]That paper, with minor, nonsubstantive editorial changes, constitutes the body of the present article, save that, at the suggestion of a referee, one (1) example was removed, solely because it involved the Leontief, fixed-coefficient, production function that the referee thought to be "of little general interest and of no interest to readers of the *QJAE*."

[20]Although Austrians should only use mathematics when doing history (Block 2000, p. 48), when they do use it this dictum applies to them as well.

[21]This is not to say that the authors of the articles might not have had something else of value to say. That is another issue.

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> A case in which this [dimensional] analysis made sense in economics was its application to Fisher's relation of exchange: $MV=PT$. This is one of the few examples in economics that comes closest to a law. One result of dimensional analysis is that there is something odd with this equation. The left part does contain a time dimension, while the right side doesn't. This is not something new and can be found in any textbook.
>
> And, from referee #3's report:
>
> There is no question that the lack of dimensional consistency is pervasive throughout mathematical economics. However, this paper does not make clear why this lack of dimensional consistency is problematical. The lack of dimensional consistency is not so much a problem in and of itself . . .

Compare the referees' statements with the following taken from two leading (basic) physics textbooks.

> Dimensional analysis is used to check mathematical relations for the consistency of their dimensions . . . *[i]f the dimensions are not the same, the relation is incorrect.* (Cutnell and Johnson 2001, p. 6; emphasis added)
>
> An equation must *always* be dimensionally consistent; this means that two terms may be added or equated only if they have the same units. . . . When a problem requires calculations using numbers with units, the numbers should *always* be written with the correct units, and the units should be carried through the calculation as in the example above. This provides a useful check for calculations. *If at some stage in the calculation you find that an equation or expression has inconsistent units, you know you have made an error somewhere.* (Sears, Zemansky, and Young 1987, p. 7; emphasis added)

Is it possible to believe that anyone with even the most elementary training in mathematics could make the statements made by these referees? This is incredible! Are the referees innumerate? How else to explain the foregoing? But there is more.

> Also from referee #1's report:
>
> The details are not very important, but the solution to the problem [of simple harmonic motion] posed [Spiegel 1967, p. 186] is $x = 1/3 \cos 8t$, where x is distance measured in feet (the deviation from the equilibrium position of the weight) and t is time measured in seconds. So exactly what kind of conversion constant [sic] do you [Barnett] want to use to convert time into [sic] distance? It is evidently not a constant, since it must be passed through the cosine expression [sic] (similar to passing units of labor or capital through the exponents [in $Q = AK^{\alpha}L^{\beta}$] above.)

But of course the details are important, because for this referee the devil is in the details. A formula, $x = A \cdot \cos \omega t$, for the displacement in simple harmonic motion can be found in Cutnell and Johnson (2001, p. 278). In this formula: x is the displacement, measured in units of length; A is the amplitude of the simple harmonic motion, also measured in units of length; ω is the constant angular speed, measured in radians/second (rad/sec); and, t is the elapsed time, measured in seconds (sec). Consequently, ωt has the dimensions rad.

Restating the formula, $x = A \cdot \cos \omega t$, with the appropriate units attached, and using feet (ft) as the unit of length, yields: $x[\text{ft}] = A[\text{ft}] \cdot \cos \omega[\text{rad/sec}] \cdot t[\text{sec}]$. Canceling the sec on the right-hand side yields: $x[\text{ft}] = A[\text{ft}] \cdot \cos \omega[\text{rad}]t$.

However, a radian is a dimensionless measure of a plane angle[22] (1 rad = $180°/\pi \approx 57.30°$). Therefore, the only unit that "must be passed through the cosine expression" is an (plane) angular measure. Of course, converting plane angular measures, whether radians or degrees, to a pure, i.e., dimensionless, number is precisely what the trigonometric operators, cosine included, do. Consequently, the equation $x = A \cdot \cos \omega t$ has the unit feet on both sides.

Compare the referee's specific equation, $x = 1/3 \cos 8t$, with the generic form, $x = A \cdot \cos \omega t$. The correspondences between the terms in these equations are: $x = x$; $A = 1/3$; magnitude of $\omega = 8$; and, $t = t$. Use these correspondences to restate the equation, $x = 1/3 \cos 8t$, with the appropriate units made explicit, as: $x[\text{ft}] = 1/3[\text{ft}] \cos (8[\text{rad/sec}] \cdot t[\text{sec}])$. Cancel the sec on the right-hand side to obtain: $x[\text{ft}] = 1/3[\text{ft}] \cos 8[\text{rad}] \cdot t$, where the term $\cos 8[\text{rad}] \cdot t$ is dimensionless. Then, as must be the case, the units on the right-hand side are identical to the units on the left-hand side; to wit, in this case, feet. Obviously, the referee's statement is erroneous.

This example brings to mind the term *idiot savant*. No doubt, this referee knows a great deal of pure mathematics; but, does he know anything at all about applied mathematics or physics? On the evidence he provides in the foregoing excerpt, the answer, at least with respect to harmonic motion, is a resounding, "NO!"

> And, yet again, from the same referee #1:
>
> If one wants an example from physics not involving time, try p. 97 [Spiegel 1967], where there is an example concerning thermal conductivity in pipes. The solution is $U = 699 - 216 \ln(r)$, where r is distance in centimeters and U is temperature in degrees. Now what kind of conversion factor do you want to use to convert distance into degrees? I conclude that physics contains the same "defect" when certain systems are examined.

[22] Http://physics.nist.gov/cuu/Units/units.html.

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Once again, this referee exhibits his ignorance of applied mathematics and physics, at least with respect to thermodynamics. In fact the dimensions on *both* sides of the equation $U \approx 699 - 216 \ln(r)$ are degrees centigrade. As the proof is somewhat lengthy it is included as an appendix.

The following, with emphasis added, is the corpus of the co-editor's letter of rejection that accompanied the referees' reports excerpted, above.

> I enclose three *thoughtful* reports on your manuscript. The referees, while sympathetic, unambiguously recommend rejection. I agree with these assessments and must reject your manuscript.
>
> The referees on occasion adopt a somewhat harsh tone. I hope you can see that they took the refereeing responsibility very seriously and have written *thoughtful* reports. They labored to understand your thinking, and the occasional harsh word is the consequence of frustration, one that I felt in reviewing your manuscript as well.
>
> The [journal] receives about 1000 manuscripts per year, and publishes less than ten percent of these. As a consequence, I am forced to reject many quite good manuscripts. Thank you for submitting your paper to the [journal]. I am sorry my response could not be more satisfying.

I submitted a *12-page* reply to the referees' reports in which numerous errors were called to the co-editor's attention, specifying, for each error, the nature thereof, and providing, for each, a detailed proof of the error.

The co-editor responded to my reply with a letter dated February 1, 2001, the corpus of which follows.

> I am responding to your letter of Jan 12, 2001.
>
> Evidently you could not see past the tone of the reports to the substance of the reports. Unfortunately, reading *your diatribe on the referees' errors has not convinced me of the error of their ways.* The case of the Cobb-Douglas production function is quite clear. Just because you think that the units associated with C-D are unnatural doesn't make it so. *Moreover, the referees are right about the units required to rationalize physics*–distanced squared or log(temperature) makes no more sense than the square root of manhours. The units are what they are, and certainly you can't really think the Cobb-Douglas production function is logically inconsistent. Like a law of nature, a production function is whatever it is.
>
> As you surmised, I am not going to reopen the file. *At the very minimum, you have failed to convince three referees and one editor of the merit of your approach.* A great deal more effort into communicating the results is going to be necessary, I suspect, to sell this work to any journal. You could try *Economics & Philosophy.*

The editor clearly states that he "agree[d] with these [referees'] assessments," that the reports were "thoughtful," that my "diatribe" did not "convince [the editor] of the error of [the referees'] ways," and that, "[a]t the very minimum, you have failed to convince three referees and one editor of the merit of your approach." My reply incorporated the material included above and in the appendix; moreover, it went into greater detail. How, then, could the editor reach the conclusions he did? Three referees and an editor at a top-tier journal and all innumerate? Never in my wildest dreams did I think that an editor and referees for one of the most prestigious English-language economics journals could be so ignorant in a matter of basic mathematics, much less that they would commit such to paper, where it cannot be denied and can, and is being preserved for posterity.

This brings me back to the basic issue, the desirability of specifically Austrian journals. Given the extent of the mathematization of economics, it is critically important that mathematics, if used at all, be used correctly in economics. Therefore, the subject matter of my original paper is very important. Moreover, if my paper is correct–if, in fact, mathematics is abused/misused in economics if for no other reason than that articles in at least one top-tier journal cannot pass the test of dimensional analysis–the paper is worthy of publication in an important venue. The fact that it was rejected by referees and an editor incompetent to the task because of a demonstrated lack of understanding of the basic mathematics of dimensions, the very subject matter of the paper, provides a sufficient reason to have alternative outlets, i.e., specifically Austrian journals, available.[23] Moreover, I think it highly improbable that referees of lesser mainstream journals would succeed where those at a more prestigious journal failed. Therefore, if my paper, and others similar in that they are counter to the prevailing orthodoxy, are to be published, it must be in journals receptive to heterodoxy. Moreover, I would not even consider submitting the instant paper to a mainstream journal of any rank. I cannot imagine such an attack against a top-tier mainline journal ever being published in such a journal. And yet, if in fact referees and editors at top-tier mainstream journals are incompetent in any relevant area this is important for the profession to know.

I conclude, therefore, that there is a need for specifically Austrian journals, not only because of the bias of mainstream journals, but also because Austrians should not have to subject their work to referees and editors incompetent in the very area of their supposed expertise.

[23] In fact, when I submitted the paper for review a colleague and I made a wager as to how quickly it would be rejected. As I recall, I said something like eight weeks or less and my colleague said more than that; he won by about two days.

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APPENDIX

Referee #1 took the equation, $U = 699 - 216 \ln(r)$, from an example in Spiegel (1967, pp. 97-98.) (Please note that I used a different edition, Spiegel (1981, pp. 103-04).) The example is formulated as a problem with three parts. The "[s]olution . . . $U = 699 - 216 \ln(r)$," which the referee took from the book, is but the solution to one part thereof. I have reproduced the relevant portion of the example immediately below. (Emphasis in original.) Subsequently, I restate, in expanded form, the example in a way that explicates the referee's error.

> The amount of heat per unit time flowing across an area A is given by
>
> $$q = -KAdU/dn \qquad (3)$$
>
> The constant of proportionality K, used above, depends on the material used and is called the *thermal conductivity*. The quantity of heat is expressed in *calories* in the cgs system, and in *British thermal units*, *Btu* in the fps system. [Because of the confusion that arose from the use of "pound" as a unit of mass and as a unit of force, in the modern version of the fps (foot-pound-second) system, the BE (British Engineering) system, the slug, not the pound, is the unit of mass.] Consider now an illustration using the above principles.
>
> A long steel pipe, of thermal conductivity $K = 0.15$ cgs units, has an inner radius of 10 cm and an outer radius of 20 cm. The inner surface is kept at 200° C and the outer surface is kept at 50° C. (a) Find the temperature as a function of distance r from the common axis of the concentric cylinders. (b) Find the temperature when $r = 15$ cm. (c) How much heat is lost per minute in a portion of the pipe which is 20 m long?
>
> MATHEMATICAL FORMULATION (Spiegel 1981, pp. 103-04). It is clear that the isothermal surfaces are cylinders concentric with the given ones. The area of such a surface having radius r and length l is $2\pi rl$. The distance dn is dr in this case. Thus, equation (3) can be written
>
> $$q = -K(2\pi rl)dU/dr \qquad (4)$$
>
> Since $K = 0.15$, $l = 20$ m $= 2000$ cm, we have
>
> $$q = -600\pi r\, dU/dr \qquad (5)$$
>
> In this equation, q is of course a constant. The conditions are
>
> $$U = 200^\circ \text{ C at } r = 10,\ U = 50^\circ \text{ C at } r = 20 \qquad (6)$$
>
> SOLUTION. Separating the variables in (5) and integrating yields
>
> $$-600\pi U = q \ln r + c \qquad (7)$$
>
> Using the conditions (6), we have $-600\pi(200) = q \ln 10 + c$, $-600\pi(50) = q \ln 20 + c$ from which we obtain $q = 4O8{,}000$, $c = -1{,}317{,}000$. Hence, from (7) we find
>
> $$U = 699 - 216 \ln r. \qquad (8)$$

Expanded Restatement. The foregoing material is restated with the units, in brackets, explicitly attached to the algebraic symbols for the variables. The dimensions of thermal conductivity are units of: energy/(time • distance • thermodynamic temperature). Therefore, K, the thermal conductivity of the pipe, is, in (cgs) units, cal/(sec • cm • °C). The units of the other relevant variables are: cm for l, dr, and r; °C for dU and U; and, cal/sec for q.

Rewriting equation (4) yields:

$$q[\text{cal/sec}] = -K[\text{cal/(sec} \cdot \text{cm} \cdot {}^\circ\text{C)}] \cdot (2\pi r[\text{cm}]l[\text{cm}]) \cdot dU[{}^\circ\text{C}]/dr[\text{cm}] \qquad (4')$$

Substituting the values for K and l yields:

$$q[\text{cal/sec}] = -0.15[\text{cal/(sec} \cdot \text{cm} \cdot {}^\circ\text{C)}] \cdot 2\pi r[\text{cm}]2000[\text{cm}] \cdot dU[{}^\circ\text{C}]/dr[\text{cm}] \qquad (5')$$

The cm unit and the °C unit in the denominator of the dimension of K cancel the cm unit in the numerator of the dimension of l and the °C unit in the numerator of the dimension of dU, respectively. Note particularly that because the units of r and dr are identical, cm, and because r is in the numerator and dr in the denominator, the units of the variables r and dr cancel out, and all that is left of these variables are their magnitudes; the algebraic symbols of these variables no longer have units attached. Therefore, canceling units yields:

$$q[\text{cal/sec}] = -600[\text{cal/(sec)}] \cdot \pi r \cdot dU/dr \qquad (5'')$$

At this point, the only units that have not canceled out are cal/sec on both sides of the equation.

Rewriting (5″) to put it in integrable form yields:

$$-600[\text{cal/(sec)}]\pi dU = q(\text{cal/sec})\, dr/r. \qquad (5''')$$

The integration of dr/r yields ln r, but the algebraic symbol for the variable r in the term ln r has been shorn of its units and only its magnitude remains, and, therefore there are no units to be operated on by the ln operator. Similarly, the integration of dU yields U, but the algebraic symbol for the variable U has been shorn of its units and only its magnitude remains. The solution to (5‴), then, is:

$$-600[\text{cal/(sec)}]\pi U = q[\text{cal/sec}] \ln r + c \qquad (7')$$

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Recall the conditions (6) i.e., $U = 200°$ C at $r = 10$ [cm] and $U = 50°$ C at $r = 20$ [cm], while remembering that r refers only to the relevant magnitudes at this point; the cm appear in brackets only as a reminder of the dimensions that r had prior to their being canceled in the equation, q[cal/sec] = $-K$[cal/(sec·cm·°C)]·(2πr[cm]/[cm])·dU[°C]/dr[cm]. Then, substituting these conditions into (7′), and solving for q and c yields: q = 408,000 cal/sec and c = -1,317,000 cal/sec. Note: the units of c are, necessarily, cal/sec, else dimensional analysis would yield inconsistent units, an absolutely certain sign of error, to wit: an incorrect relation.

In order to solve for U including, the appropriate units, rewrite (7′) (substituting q = 408,000 cal/sec for q and c = -1,317,000 cal/sec for c) as:

$$-600[\text{cal}/(\text{sec}\cdot{}^{\circ}\text{C})]\pi\, U[{}^{\circ}\text{C}] = 408{,}000\ [\text{cal/sec}]\ \ln r - 1{,}317{,}000\ [\text{cal/sec}] \qquad (8')$$

Isolating the U term yields:

$$U[{}^{\circ}\text{C}] = (408{,}000\ [\text{cal/sec}]\ \ln r - 1{,}317{,}000\ [\text{cal/sec}])/(-600[\text{cal}/(\text{sec}\cdot{}^{\circ}\text{C})]\cdot\pi) \qquad (8'')$$

As the units cal/sec appear in every term in the numerator and in the denominator of the right-hand side of 8″, they may be canceled, yielding:

$$U[{}^{\circ}\text{C}] = (408{,}000\ [{}^{\circ}\text{C}]\ \ln r - 1{,}317{,}000\ [{}^{\circ}\text{C}])/(-600\pi) \qquad (8''')$$

or

$$U[{}^{\circ}\text{C}] = 699[{}^{\circ}\text{C}] - 216[{}^{\circ}\text{C}]\ \ln r. \qquad (8'''')$$

Because, as previously shown, ln r is dimensionless, it is obvious that the dimensions on both sides of equation (8″″) are degrees Celsius, and, therefore, identical, as must be the case.

However, equation (8″″) is the very solution (*cum* appropriate units) that the referee cited in his report, to support his position.

Therefore, both Referee 1's undeniable implication that the units on the different sides of the equation, $U = 699 - 216 \ln r$, are not the same, in that the units on the left-hand side are degrees Celsius and the units on the right-hand side are centimeters, and his conclusion "that physics contains the same 'defect' [i.e., the failure to properly account for units and, therefore, the inconsistency between the two sides of equations] when certain systems are examined, are incorrect. *QED.*

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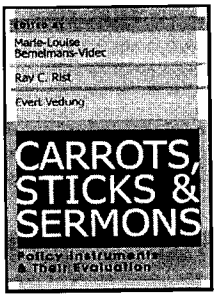

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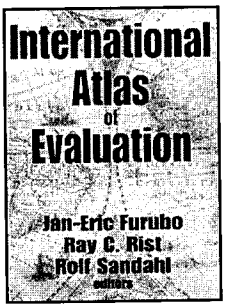

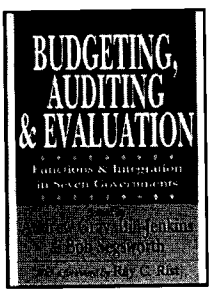

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